A current-driven helicene rotor read through the density field: helical geometry, one carrier, and five divergences

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Abstract

Singh et al. report a dithioacetyl[13]helicene bridging two gold electrodes of a mechanically controllable break junction at a 4.2 K bath [1]. In 316 junctions the current switches among two to five levels above a bias of magnitude near 200 mV; in the 122 junctions that resolve three or more levels every observed jump follows one cyclic order, the order of the levels reverses with the bias polarity in the junction shown, and the onset current of the later current rise is lowest at intermediate electrode displacement. This analysis reads that record through Fundamental Density Theory (FDT). On the record's own inputs FDT returns the record's values, the identity map of the convergence statement, save the simulated steady rotation, which the record prints as an angular velocity and, at about the same value, as a frequency, and the lower end of the slope range in the record's main text, which Table S2 does not print, and FDT reads the record at quoted clauses. In this analysis's reading the helicene's two-turn helix is a helical geometry in the sense of the twist anchor P-5, its hand is one carrier of a flow direction (P-4), the electrodes' phonons and the molecule's vibrations are the one carrier of I-2, the rotor's gravitational window is a correct small number (I-1), and every channel of the junction enters its total gravitating energy once (I-7). FDT is a true extension of general relativity and quantum mechanics, and the analysis states five predictions they do not make: a field-odd and a magnetization-odd zero-bias conductance with a hand-odd part in enantiopure junctions, from the twist field of P-5 and the helical window of the extended equivalence principle, and isotope shifts of the fitted rotation barrier, the molecular conductance peak and the shoot-up voltage, from the density channel of I-7. Each carries a randomized cooldown design, an exact permutation test, an executed false-rejection rate and three decision rules.

1 Framework

1.1 Source, status and verbs

The record is the main text, the Methods and the Supplementary Information of the target [1]; the supplementary videos and the Source Data file are not part of it (SR-065, L330; SR-295, L1411). Its source_status is experimental. Verb discipline, declared once: what the record returns from its apparatus is measured, observed or reported; everything else in this analysis is derived, estimated, reconstructed or illustrative-assumed, and a fit, an estimate, a calculation or a simulation of the record keeps that name. Citations name the claim row (SR-nnn, whose verbatim fragment fixes the words), the physical line of the source record (L with its number), and, where the record's data under-determine its reading, the row SA-nn that names the gap. Every number the record does not print is an assumption row U-nn with its provenance; a sign-lost or flattened exponent of the record carries its own row SL-nn.

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FDT is a true extension of general relativity and quantum mechanics: it agrees with their data in full and declines their readings only where its invariants read the same record differently.

1.2 One substance, its bridges, and the strand rate

The chain $E/m = c^2 = 1/(\varepsilon_0\mu_0) = (d/t)^2$ is one identity read four ways (0.1, 0.1a), with E an energy, m a mass, ε_0 and μ_0 the two responses of the medium, d a length and t a time. Its bridges are constants of the medium and are displayed with it, for a pattern q with rest energy E_q, mass m_q, angular frequency ω_q, period T_q and Compton length ℓ_q, with h the Planck constant, $\hbar = h/2\pi$, π the circle constant, c the strand rate and m the metre:

$$\begin{aligned} E_q &= m_q c^2 = \hbar\omega_q, \qquad T_q = \frac{2\pi}{\omega_q} = \frac{h}{E_q}, \\ \ell_q &= cT_q = \frac{h}{m_q c}, \qquad \frac{d}{t} = c = 299\,792\,458 \text{ m s}^{-1} \text{ exactly}, \end{aligned} \tag{1}$$

with ℓ_q never a support radius (0.1a). Here c is the strand rate of the omnium, derived in 0.1d: the two responses give $c^2 = 1/(\varepsilon_0\mu_0)$, the rate converts the time reading of the omnium into its space reading and, squared, its matter reading into its energy reading. In the words of 0.1d, "a closed pattern's strand runs at c on a helix: $v^2 + u^2 = c^2$ (translation v, circulation u)", and "Time is circulated strand and space is translated strand; c converts the one into the other." The inertia of a closed pattern is E/c^2 with the stress of its closure included (von Laue, 0.1d), and its translation share v^2/c^2 is kinematic. The open stroke is the other half of the picture (I-2): "An open stroke's run does not circulate"; "Its grades turn about the run on a helix of radius $\bar{\lambda} = \hbar c/E = c/\omega = \lambda/2\pi$", standing at $\pi/4$ with "higher frequencies on inner cylinders"; "The helix is the locus of the turning grades; the transport is the run at c." The open stroke's $\pi/4$ "is the equality of its two rates, and only the open stroke has them equal at every frequency" (I-2), while 0.1d's rectangle of the two readings of a closed pattern's strand is "largest at $\vartheta = \pi/4$".

1.3 The seven invariants as this analysis uses them

I-1, the universal force law. The law holds always, at all scales, between two bodies, with F the force between them, G Newton's constant, α_1 and α_2 the exterior inputs $R_{s,i}/d$ of two nonoverlapping spherical supports at separation d (α_i either of them), $\mathcal{M}_1$ and $\mathcal{M}_2$ the two bodies' total gravitating energies over c^2 and $F_{\max} = c^4/4G$ the force ceiling; on the pair domain, the inputs evaluated at monopole order, the second line is exact, not an asymptote:

$$\begin{aligned} F &= \frac{c^4}{4G}\,\alpha_1\alpha_2 < F_{\max} \qquad (0 < \alpha_i < 1), \\ F &= \frac{G\mathcal{M}_1\mathcal{M}_2}{d^2}. \end{aligned} \tag{2}$$

The interval ladder is kept: $0 < \alpha < 1$ is universal, $F < F_{\max}$ holds wherever the inputs occupy that interval, and $F \le F_{\max}/4$ is the pair-domain statement alone. Two consequences carry this analysis. "Force × length = energy": read in angular form, a torque integrated over an angle is a work. And, quoted whole: "A *driven* observable (induced magnetisation, rectified signal, rate) vanishes at zero drive and never 'recovers' the static force." At condensed-matter compactness the bare law returns a small number: a correct prediction, not a wrong-tool symptom — and not the measured binding scale, which is reached only through a declared response kernel ("rate ≠ force"). The overlapping, nonspherical molecule–electrode configuration takes a derived evaluation (O-5); no torque or barrier of the record is written here as an I-1 pair force.

I-2, one carrier. "photon = graviton = gluon = phonon = magnon = the same spin-1 excitation of the density field, at different density / geometry regimes." "There are no independent force carriers. 'Mediation' is a coordinate artifact; interactions are curvature plus geodesic motion." The identity is carrier-only: the braided closures of I-5 are never inside it.

I-3, the three faces. α is downstream of the solved field equation, which is unchanged, with $G_{\mu\nu}$ the Einstein tensor, $T_{\mu\nu}$ the stress tensor, μ and ν its two spacetime indices and κ the Einstein coupling:

$$G_{\mu\nu} = \kappa\, T_{\mu\nu}, \qquad \kappa = \frac{8\pi G}{c^4}, \qquad \kappa F_{\max} = 2\pi. \tag{3}$$

On an on-shell spherical solution, with $R_s = 2G\mathcal{M}/c^2 = \mathcal{M}c^2/(2F_{\max})$ the Schwarzschild radius of the total gravitating energy, $\mathcal{M}$ that energy over c^2, r_f the declared evaluation radius, σ the branch tag, α_σ the curvature ratio on branch σ, α_{ext} and α_{int} its exterior and interior branches, X_{ext} the exterior gap odds and r_c the finite-core cutoff, whose value is not written here (O-1), the branch-tagged curvature ratio and its gap odds are

$$\begin{aligned} &\alpha_\sigma = \left(\frac{R_s}{r_f}\right)^\sigma, \qquad \alpha_{\text{ext}} = \frac{R_s}{r_f} \;\; (\sigma = +1,\; R_s < r_f), \\ &\alpha_{\text{int}} = \frac{r_f}{R_s} \;\; (\sigma = -1,\; r_c \le r_f < R_s), \qquad X_{\text{ext}} = \frac{R_s}{r_f - R_s}. \end{aligned} \tag{4}$$

The exact optical metric in areal coordinates, with ℓ_{opt} the optical length, d the differential and $\mathrm{d}\Xi^2$ the line element of the unit two-sphere, is

$$\mathrm{d}\ell_{\text{opt}}^2 = \frac{\mathrm{d}r_f^2}{(1-\alpha_{\text{ext}})^2} + \frac{r_f^2\,\mathrm{d}\Xi^2}{1-\alpha_{\text{ext}}}, \tag{5}$$

and generalised Snell's law is the Fermat jump law of this metric with its exact index. Containment: for the same stress tensor and data FDT and general relativity return the same curvature, and α alone produces no divergence. A bound configuration carries two charts, both declared: the exterior atlas of the source and the interior chart read with its skin at the fold and its skin radius R_{room} taken from data, with no transfer map between them. Every datum about an interior is a profile-weighted mean with its probe weight named (the observation-region rule).

I-4, one statement in four limits. "Each form is the same statement read in a different limit." The quantum face, quoted whole: "QM is helical geodesics on truncated density cones. The wavefunction $\psi = A\,\mathrm{e}^{\mathrm{i}\phi}$ is the projection of a helix onto the plane normal to the cone axis; 'superposition' is ignorance of the helical phase ϕ_0 at observation. The universe is deterministic; there are no probability amplitudes." (I-4).

I-5, braids and confinement eigenvalues. Matter is braided photon helices: closed loops of n open helical strands, the helix count fixing the class and the confinement position the mass within a class. The record's electrons are $n = 3$ closures, and so is the proton (I-5). For a pattern confined to a domain Ω with boundary data B, braid configuration n, orientation χ and position t on the inside/outside chart, with D the confinement operator, u_q the mode and ω_q its frequency,

$$D(\Omega, B; n, \chi, t)\, u_q = \omega_q\, u_q, \qquad m_q c^2 = \hbar\omega_q, \tag{6}$$

and no form of D, its domains, boundary data or spectrum is written here (O-9). Mass is a confinement eigenvalue: no mass formula, no anchor radius and no absolute address is written for any named particle, and no support is identified with a Compton length. Each nucleus of the junction is one pattern (0.1b); the deuteron's helix count and its same-n or different-n relation to the proton are not listed in the core and are not assigned here. The two mass ratios the operator must reproduce are held-out targets, read in the status ledger.

I-6, the bounded map. Every bounded-map use names its application A-1 to A-5 (0.4); the odds of an application is algebra, $X = \alpha/(1-\alpha)$, with no probabilistic reading; the open interval is never closed, and the endpoints are the one-sided limits $\alpha \to 0^+$ and $\alpha \to 1^-$. The record's directionality is a percentage of counted jumps and is never an α (SA-35).

I-7, density equivalence. Every channel enters the total gravitating energy once, with M the rest mass, E every non-rest energy, P the pressure, V the volume, T the temperature, a the radiation constant and σ_{SB} the flux constant, which never enters $\mathcal{M}$ directly:

$$\mathcal{M} = M + \frac{E}{c^2} + \frac{PV}{c^2} + \frac{aT^4V}{c^2} + \dots, \qquad a = \frac{4\sigma_{\mathrm{SB}}}{c}, \tag{7}$$

with $a = 7.566 \times 10^{-16}\ \mathrm{J\,m^{-3}\,K^{-4}}$. The Discriminator, quoted with its scope: "For purely density-coupled equilibrium observables, a heavier isotope → larger R_s → higher α → **larger** response — opposite in sign to conventional reduced-mass scaling." Discipline 2, quoted whole: "A sign prediction competing with geometric, electronic or inertial channels is written as a sensitivity-weighted sum $\delta \ln O = \sum_i S_i\, \delta \ln x_i$ with every S_i defined (held-fixed variables stated). The density-channel **input** sign is the FDT discriminator; the **observable** sign is $\mathrm{sgn}(\prod_i S_i)$ and stays conditional until the sensitivities are established." Chart discipline 5 of I-3 fixes the isotope case: "Fixed-geometry perturbations (isotope substitution: P, r, packing all fixed) move compactness only; pressure-trajectory maps do not apply to them."

The helical window and the medium window (0.1c). The extended equivalence principle, quoted: "moving at constant speed, on the pattern's own clocks and rulers, through a density gradient is gravity"; free fall is that motion through a density gradient; the bookkeeper reads the common rescaling as acceleration. Beside the gravitational window, 0.1c names "a pattern whose rest energy depends on where it sits in a twist — the helical density gradient of P-5 — takes that energy as its clock factor." With $\mathcal{E}$ the pattern's rest energy where it sits, m its held moments, B "the twist's magnetic field where they sit", $\mathcal{E}_{\mathrm{ind}}$ the energy of the moments the twist induces, the work of inducing them included, $\mathcal{E}_0$ the rest energy outside every twist, a constant (0.1d), $\mathfrak{m}$ the pattern's clock factor, $\mathfrak{A}$ its action, t_{own} the time kept on its own clock and z the coordinate along the twist's gradient, and with the fall equal to its push $-\partial_z \mathcal{E}$ in the slow limit, each m held at its settled value,

$$\begin{aligned} &\mathcal{E} = \mathcal{E}_0 + \mathcal{E}_{\mathrm{ind}} - \sum \mathsf{m}\cdot\mathsf{B}, \qquad \mathcal{M} = \frac{\mathcal{E}}{c^2}, \qquad \mathfrak{m} = \frac{\mathcal{E}}{\mathcal{E}_0}, \qquad \mathfrak{A} = -\int \mathcal{E}\, \mathrm{d}t_{\mathrm{own}}, \\ &\mathcal{M}\,\frac{\mathrm{d}^2 z}{\mathrm{d}t^2} = -\partial_z \mathcal{E} = -\partial_z \mathcal{E}_{\mathrm{ind}} + \sum \mathsf{m}\cdot\partial_z \mathsf{B}. \end{aligned} \tag{8}$$

With $g_{\mu\nu}$ the metric and $\mathcal{E}$ positive and fixed by the event alone, $\mathfrak{A}$ is "the geodesic action of $\mathfrak{m}^2 g_{\mu\nu}$", and the law it gives is the acceleration the bookkeeper reads on $g_{\mu\nu}$, toward smaller $\mathfrak{m}$, exact. "The gradient of $\mathcal{E}$ gives the push and its second derivatives the spring; a uniform level added to $\mathcal{E}$ changes $\mathcal{M}$ and leaves the push unchanged, and a uniform twist, a uniform level of $\mathfrak{m}$, turns a held moment and pushes nothing." In the helical window $\mathfrak{m}$ belongs to the pattern, so "patterns whose held and induced moments, summed per unit $\mathcal{E}$, differ along $\partial_z \mathsf{B}$ fall differently where they sit". The universality of free fall is the gravitational window's, and it stands. The medium's clock factor of 0.1c is derived for a stress tensor of perfect form: the temperature at zero net conserved count, and the enthalpy per count "With a conserved count N and fixed entropy per count"; it "is the reading of its flow", never the rate of a clock the medium carries. This analysis states neither condition for the junction, so the record's temperatures stay inputs of its fits and no clock rate is read off them (SA-18).

The anchors. P-2: "eigenstates, phonon modes and orbitals are nodal patterns of the driven density field", and "mode geometry is set by the boundary conditions (the clamps, P-3), not by the medium". P-3: "Atomic nuclei are the saturated density cores of a material's Chladni volume: fixed pinning sites. The site's saturation coordinate $\alpha_{\text{core}} \to 1^-$ (never 1) is the *skin* value of the nucleus's interior chart (0.6, I-3) — 'core' names the nucleus as a pinning site, not its geometric centre, which is its dilute region"; and "the site's saturation coordinate is not the exterior compactness of the same nucleus ($\ll 1$ for a laboratory nucleus); declare both charts whenever both appear". P-4: "The truncated density cone at a point is the local light cone"; "every density cone carries a flow direction — the cone's own circulation sense, the way its helical geodesics wind about its axis, intrinsic and fixed once for all"; "The flow direction is not the local velocity in the overlap region"; "chirality is one carrier of a flow direction, not the only one"; and the rule's "magnitudes are I-1 derivations with a declared kernel". The aperture index of P-4 enters no number here (O-8). P-5, quoted whole: "A magnetic field is a macroscopic helical density gradient of the omnium: the bivector grade of the density field coherently aligned along an axis; vortex lines are bivector topological defects. Imposing a physical twist (torsion, helical geometry) on a material *is* establishing a magnetic field; mechanical vorticity and magnetic moments are different grade projections of one density-gradient topography, with no carrier exchange (I-2). Quantitative twist → moment forms are derived in-manuscript through I-1/I-2 with a declared kernel." This analysis writes neither that kernel nor the map from a circulating charge to an I-1 input (O-6). Curvature, a tide or a density gradient is read between neighbours or against a reference path, never off one pattern (I-3a, Use item 7); every comparison below is built so.

1.4 Chart inventory

The chart inventory is declared here, at first use, and every α token below names its application (0.4, I-3 chart discipline 1). A-1 and A-2 carry geometric warrant; A-3, A-4 and A-5 do not, and their tokens carry a range and nothing else.

token	application	warrant	evaluation in this analysis
α_σ, α_{ext}, α_{int}	A-1 compactness, the atlas	yes: two lengths the physics fixes	field point: the bound rotor at $r_f = 1.0$ nm on the exterior branch (U-10, U-12); the Au, S and C clamp nuclei at their rms charge radii (U-13); configuration: the support radius, written R_b; source: R_s of the total gravitating energy
X_{ext}	A-1 odds	yes	$R_s/(r_f - R_s)$, algebra and nothing else
β_σ	A-2 compactification	yes	computational chart only, never a force, optical or density slot; unused
α_{ovl}	A-3 overlap and contrast	no	the steric overlap of molecule and electrode apex (SA-13), the manuscript's reading: token and range only; no value, no threshold, no side (O-2)
α_{conf}	A-4 confinement	no	token only; no value and no ordering (O-3)
α_{mode}	A-5 mode manifestation	no	token only: it names the phonon and vibration regimes of I-2 and ranks nothing
$\alpha_{\text{core}} \to 1^-$	saturation diagnostic of P-3	schematic only	the skin value of an Au, S or C nucleus's interior chart, skin at the fold, R_{room} from data (U-13); no transfer map to the exterior atlas

1.5 Notation guard

The record's symbols that meet reserved tokens are renamed on every surface; the notation guard below is the census, in three parts. One symbol carries one meaning: a bare α is the curvature ratio, n the strand count, σ the branch tag (or σ_{SB}), κ the Einstein coupling, X the odds, D the confinement operator, Ω the confinement domain and a the radiation constant.

source token	source meaning	manuscript name and guard
θ, $\dot{\theta}$, θ_0, θ'	rotation angle and its rate	Θ, $\dot{\Theta}$; θ is I-3's Snell and deflection angle; ϑ is 0.1d's pitch
τ, τ_w, τ_{fl}, τ_f, τ_{BO}, τ_c, $\tilde{\tau}_w$, $\vec{\tau}_{LR}$, τ_L, τ_R	torques; torque flow	$\mathcal{N}$ with the record's subscripts ($\mathcal{N}_{\mathrm{w}}$, $\tilde{\mathcal{N}}_{\mathrm{w}}$, $\vec{\mathcal{N}}_{\mathrm{LR}}$); τ is 0.1a's stroke duration and I-5's τ lepton
I; I, I_{onset}, I_{max}, I_h, I_l, I_p, I_L	moment of inertia; current	$\mathcal{I}$; I with subscripts; I-1 to I-7 are the invariants
$L = I\dot{\theta}$, Λ	angular momentum; kinetic angular momentum	$\mathcal{L}$, $\mathcal{L}_{\mathrm{kin}}$; L names I-4's layers and the record's line loci; Λ is core 0.7's Λ_{eff} and 0.1d's strand runs
L, R, M (subscripts)	left electrode, right electrode, molecule	upright L, R, M; R names the Schwarzschild family
V; V_{onset}, V_{max}, $V_{shootup}$	voltage	$\mathcal{V}$ with subscripts; V is I-7's volume
$V(\theta)$, V_0, $\tilde{V}$	potential landscape, its amplitude, tilted potential	$\mathfrak{V}(\Theta)$, $\mathfrak{V}_0$, $\tilde{\mathfrak{V}}$
W, W_τ, W_η, δW	work per cycle; friction work	$\mathcal{W}_{\mathrm{w}}$, $\mathcal{W}_{\mathrm{f}}$; W is reserved
R, R_0, R_{AB}, R_{AC}, R^0_{AB}, k_+, k_-, ω_0 (SI Eqs. (6)–(10)); ω_0 (SI Sec. 4.2.2, $s = \omega_0 t$)	rotation rate, attempt frequency, hopping rates, the hops' prefactor; the rescaling frequency	$\mathcal{R}$, $\mathcal{R}_0$, $\mathcal{R}_{\mathrm{AB}}$, $\mathcal{R}_{\pm}$, $\mathcal{R}_{\mathrm{hop}}$; $\mathcal{F}_0$; ω is 0.1a's mode frequency
ω_s	steady angular velocity	$\dot{\Theta}_{\mathrm{s}}$
G, G_0, G_{max}; G^r, G^a, G_M	conductance; Green's functions	$\mathcal{G}$, $\mathcal{G}_0$, $\mathcal{G}_{\mathrm{max}}$; G^{r}, G^{a}; G is Newton's constant (0.2)
H, H_M, $\dot{H}$	Hamiltonian	$\mathcal{H}$; H is I-5's helicity sign

source token	source meaning	manuscript name and guard
A, A_M, ΔA; A, B (SI Eq. (2))	spectral functions; cubic-fit constants	$\mathcal{A}$; c_1, c_3; A-1 to A-5 are core 0.4's applications
A, B, C; m1, m2, m3; HH, TT, HT; δ, J, s, d, dd, t, m	current states; minima; junction types; the NMR data of SA-115	the record's labels in upright text, never math symbols; B is I-5's boundary data and braid group
B (SI Eq. (25))	the field of the "Lorentz" force, which "may arise from current-induced forces" (SR-531)	$\mathcal{B}_{\mathrm{Lor}}$; 0.1c's twist field B (B_{tw} the helicene's, DC-1's reading; $\mathsf{B}_{\mathrm{app}}$ the applied)
D (main text); D, D_0 (SI)	directionality; diffusion coefficients	$\mathsf{D}_{\mathrm{dir}}$; $\mathcal{D}_\Theta$, $\mathcal{D}_0$; D is I-5's confinement operator
γ (main text, SI Sec. 2.4); γ_L, γ_R, Γ_ℓ	barrier-reduction fraction; level broadenings	g_{w}; w_{L}, w_{R} (one quantity, matrix or scalar); γ is 0.1d's boost factor, Γ an I-5 curve and I-5b's width
η, $\tilde{\eta}$, η_{ph}	friction coefficient (an action)	kept, with $\hbar$ written where the record writes $10\hbar$ (SR-289)
T; T_{eff}; $T(E, \theta)$	temperature; effective temperature; transmission	T (I-7's temperature), T_{eff}; $\mathsf{T}(E, \Theta)$; $T_{\mu\nu}$, T_q and the labels T-n keep their meanings
t; t_d, t_{esc}, t_{trap}, $\tilde{t}$; t, t_L, t_R, $\vec{t}_{LR}$	time; dwell, escape and trapping times, $\tilde{t} = t_{esc}/t_{trap}$ (SI Eq. (110)); couplings	t, t_{d}, t_{esc}, t_{trap}, $\tilde{t}$; t_{c}, t_{L}, t_{R}, $\vec{\mathsf{t}}_{\mathrm{LR}}$; t is I-5's chart position too
n (axis), n (Methods Eq. (5)), $n(t)$; n_F, $\bar{n}_F$, Δn_F	rotation axis; coupling-plane normal; step count; Fermi functions	$\hat{\mathbf{o}}_{\mathrm{rot}}$; $\hat{\mathbf{o}}_{\mathrm{LR}}$; n_{s}; f_{FD}, $\bar{\mathsf{f}}_{\mathrm{FD}}$, $\Delta\mathsf{f}_{\mathrm{FD}}$; n is I-5's strand count, $\mathbf{e}_\parallel$ and $\mathbf{e}_\perp$ 0.1d's strand-plane basis
N, N_{cycle}, $N_{A\to B}$, N_0	counts	N with subscripts; N is 0.1c's conserved count
P, P_L, P_M, P_R; p_L, p_R, p_{L0}, p_{R0}	projection operators; hop probabilities	P_{L}, …; p_{L}, …; P is I-7's pressure, P-1 to P-5 the anchors
Q, Q_p	pumped charge	Q_{p}; Q is I-5's charge

source token	source meaning	manuscript name and guard
α, α_n (SI Eq. (56))	dynamical phase	Φ_n; a bare α is core 0.3's curvature ratio
φ, φ_0, φ_n	scattering states	Υ, Υ_0, Υ_n; ϕ is the helix phase and ψ the wavefunction of I-4, ψ also I-3a's angle
ρ	density matrix	$\hat{\mathcal{P}}_{\mathrm{occ}}$; ρ (and its variant ϱ) is core 0.6's density and core 0.3's section radius
Σ, Σ^r, Σ^p	self-energies	$\mathcal{S}^{\mathrm{r}}$; Σ is the core's sum and 0.1d's bivector $\mathbf{\Sigma}$
μ_L, μ_R; E_S, E_{Au}, E_F, E_b, E_A^0	chemical potentials; level, Fermi and barrier energies	E_{L}, E_{R}; E_{S}, E_{Au}, E_{F}, E_{b}, $E_{\mathrm{A}}^{(0)}$; μ is μ_0
ϵ, ε_n	extinction coefficient; infinitesimal; energy variable (SA-96); eigenenergies	words; 0^+; $\tilde{E}$; E_n; ε is ε_0
a; d; r; s; v	sub-step $2\pi/3$ (SR-574); step 2π (SR-571); randomness parameter; rescaled time; mean angular velocity	$\Delta\Theta_{\mathrm{s}}$; 2π; r; $\hat{t}$; $\langle\dot{\Theta}\rangle$; a is the radiation constant, d core 0.1's length, s I-1's separation, v 0.1d's translation
r_i, v_i, m_i, F_i; s, p_1, p_2	atomic positions, velocities, masses, forces; S–S axis and p-orbital directions	$\mathbf{x}_i$, $\dot{\mathbf{x}}_i$, m_i, $\mathbf{f}_i$; $\mathbf{o}_{\mathrm{SS}}$, $\hat{\mathbf{o}}_1$, $\hat{\mathbf{o}}_2$; F is I-1's force, p 0.1d's momentum
x, y, z	axes	z the junction axis (DC-2 takes it as 0.1c's z, the manuscript's own reading); z_1, z_2 are 0.3a's coordinates; x and y in text only, x being core 0.4's odds input
S (sulfur), Ω (ohm)	element; unit	upright text S; Ω; Ω is I-5's confinement domain
(none; added)	asymmetries; magnetization; isotope changes	$\mathcal{Y}_{\mathrm{B}}$, $\mathcal{Y}_{\mathfrak{M}}$; $\mathfrak{M}$; $\Delta\ln\mathcal{I}$, $\Delta\ln\mathcal{M}$; hands written (P) and (M) in text, never χ (I-5, I-1)

1.6 Probe weights and where the invariants act

Each datum of the record is a profile-weighted reading with its probe weight named (I-3, observation-region rule):

datum	probe weight	rows
I–V curves and I–t traces	the bias current's path through one molecule	SR-241, SR-041
differential conductance	the lock-in's linear response to a small modulation, at zero bias for the conductance level	SR-242, SR-125
conductance histograms	the pull–push sampling of all configurations, without data selection	SR-339
rotation rate	cycle counting over a trace	SR-379
dwell times	state residence	SR-369
inelastic steps of Fig. 3b	inelastic thresholds	SR-128
estimates of the HOMO energy and the HOMO–LUMO gap	cyclic voltammetry and the onset of the longest wavelength absorption, of the molecule in solution, the HOMO through a reference level the record does not state (SA-50, SA-51)	SR-304, SR-302

Every invariant is used, and here is where (Use item 1). I-1 gives the rotor's window and the angular reading of work in the system chart and in the observation map; I-2 gives the one carrier of the electrodes' phonons and the molecule's vibrations; I-3 gives the atlas, the two charts of every clamp nucleus and the probe weights above; I-4 gives the reading of the record's semiclassical split; I-5 gives the electrons and protons as $n = 3$ closures, the eigenproblem of Eq. (6) and the braid reading of the isotope substitution; I-6 gives the chart inventory; I-7 gives the junction's ledger and the density channel of the isotope predictions.

2 System chart table

The system's patterns, each on its declared chart, with every value derived from the rows named. The rotor is the bound molecule, both thioacetyl groups converted to Au–S bonds at the terminal sulfur atoms (U-10), because the record's calculated junctions connect the molecule to Au "via a sulfur atom" at each side (SR-461, L2496) and no line of the record states whether the acetyl groups stay in the measured junction (SA-113); its structure was analysed only on a sample sublimed outside the junction (SR-311, L1789; SA-113). The window of each pattern is its own compactness, $\alpha_{\mathrm{ext}} = \mathcal{M}c^2/(2F_{\max}r_f)$ (0.1c), and the small number is a correct reading (I-1); the constants are those of CODATA 2018 [9], the atomic masses those of AME2020 [10] and the nuclear charge radii those of the compilation [11] (U-02 to U-13).

pattern	chart and evaluation	value	rows
bound rotor, $C_{66}H_{64}N_2O_3S_2$	A-1, exterior branch, field point $r_f = 1.0$ nm	$\alpha_{\mathrm{ext}} = 2.5 \times 10^{-42}$	U-10, U-12
Au nucleus as clamp	A-1 at r_f the rms charge radius, 5.4371 fm, a skin-weighted second moment with the charge density as probe weight; interior chart, skin at the fold	$\alpha_{\mathrm{ext}} = 8.9\times10^{-38}$; $\alpha_{\mathrm{core}} \to 1^-$, schematic	U-13
S nucleus as clamp	A-1 at the rms charge radius 3.2611 fm, weighted as for Au; interior chart as for Au	$\alpha_{\mathrm{ext}} = 2.4 \times 10^{-38}$	U-13
C nucleus	A-1 at the rms charge radius 2.4702 fm, weighted as for Au; interior chart as for Au	$\alpha_{\mathrm{ext}} = 1.2 \times 10^{-38}$	U-13
electrons and protons	$n = 3$ closures (I-5); confinement eigenvalues, no address	no value written	—
phonons, vibrations	the one carrier of I-2; A-5 token	no value written	SR-207, SR-264
junction, thermal term	I-7 ledger, aT^4V_{j}/c^2 with $V_{\mathrm{j}} = 8\times10^{-27}$ m^3	2.1×10^{-56} kg at 4.2 K; 1×10^{-53} kg at 20 K	U-14, SR-032, SR-098

The two charts of each clamp nucleus are kept apart, as P-3 requires: its exterior compactness at its own radius is of order 10^{-38}, while its saturation coordinate on its interior chart, read at its skin, is the schematic $\alpha_{\mathrm{core}} \to 1^-$; no map is written between them, and no profile of the nucleus is written (O-4). The rotor's window is the same kind of number at a larger radius and a larger mass. The junction's mass $\mathcal{M}_{\mathrm{j}}$, written with every channel once, with M the rest mass of the rotor and the electrode apices, E_{rot} the rotor's rotational kinetic energy, E_{heat} the heat the wind work $\mathcal{W}_{\mathrm{w}}$ delivered per turn leaves in the electrodes (phonons and electron–hole pairs), the work's one entry, E_{bias} the electrostatic energy of the bias, and aT^4V_{j}/c^2 the thermal term of the junction volume V_{j} at the junction temperature T, which the record assumes and does not measure (SA-18), is

$$\mathcal{M}_{\mathrm{j}} = M + \frac{E_{\mathrm{rot}}}{c^2} + \frac{E_{\mathrm{heat}}}{c^2} + \frac{E_{\mathrm{bias}}}{c^2} + \frac{aT^4V_{\mathrm{j}}}{c^2}. \tag{9}$$

The wind work and its heat are one channel: the heat is the work's destination, not a second entry.

3 Observation map

Each row is anchored to the record's own equation or section, carries the verb class of its claim rows, and names the clause at which this analysis reads it. A row that returns the record's value from the record's own inputs is the identity map of Use item 2 and corroborates no invariant; containment belongs to I-3 and to the L2 layer of I-4 alone.

record item	verb class	rows	reading in this analysis
cyclic switching among two to five current levels (main text; SI Sec. 2.3)	measured	SR-024, SR-051	the current crossing the junction as helical geodesics of $n = 3$ closures (I-4, I-5)
one cyclic direction where three or more levels resolve (SI Table S1)	measured; a count	SR-053, SR-364	a percentage of counted jumps, never an α (I-6)
the level sequence inverted at negative bias (Fig. 1g)	measured, label space	SR-048	the cyclic sequence of current levels reverses (SA-07)
rotation as the mechanism (main text)	attribution	SR-056, SR-057	the record's, with its verbs (SA-10)
Arrhenius fits and Table S2 (SI Eqs. (4)–(5))	fitted	SR-392, SR-381	identity map; a rate is no force (I-1)
dwell-time fits and means (SI Sec. 2.3.1)	fitted; measured	SR-372, SR-373	identity map (SA-64)
backward-hop bounds (SI Sec. 2.4.1)	estimated	SR-418, SR-423	identity map; the mirror premise declined once (SA-70)
DFT barriers and transmissions (SI Sec. 3)	calculated	SR-470, SR-492	nodal patterns set by clamps (P-2, P-3)
torque work as a loop area (Methods Eqs. (4)–(5))	model	SR-161, SR-294	algebra in the coupling plane (SA-49)
wind torque vanishing at zero bias (Methods)	model	SR-269	a driven observable (I-1)
semiclassical split (Methods Eq. (1))	model; estimated	SR-255, SR-258	one statement in two limits (I-4)
Langevin crossover and current rise (SI Sec. 6.2.5)	simulated	SR-655, SR-672	identity map (SA-111), save the steady rotation, which the record prints as an angular velocity and, at about the same value, as a frequency (SR-661, SR-684)
bath, assumed and model temperatures (main text; SI Sec. 6.2.3)	reported; estimated	SR-032, SR-098, SR-640	inputs of fits; no clock rate (0.1c, SA-18)
onset current lowest at intermediate displacement (Fig. 2g,h)	fitted, defined at the record's predefined threshold (SR-349, SR-350; SA-06, SA-58); a count	SR-109, SR-110	identity map; the record's "suggest" kept (SA-21)
anthracene control (SI Sec. 2.5.2)	measured	SR-115, SR-436	chirality removed with every other difference (SA-22)

Cluster 1: helices on cones and cylinders (0.1d, I-2, I-4, P-4). The clauses are quoted in the framework. In this analysis's reading the record's electrons, $n = 3$ closures (I-5), cross the junction as the helical geodesics of I-4, and the helicene's "two-turn" helix (SR-220, L1011) is a helical geometry in the sense of P-5 (Cluster 4). The record's attribution stays its own, with its verbs: "we attribute these observations to current-induced molecular rotation", "where injected electrons transfer momentum to the helical molecule" (SR-056, L301–L302; SR-057, L302–L303; SA-10); so does its conclusion, "The molecular machine studied here converts angular momentum carried by an electric current into directional rotation of a chiral molecule, in a regime governed by quantum transport and nanoscale material properties" (SR-172, L658–L659; SR-173, L659; SR-174, L669; SA-32). The current and the rotor are never read as a strand's translation and circulation (0.1d): the current is a count of closures

crossing per unit time, the rotor an extended pattern turning about its axis. The rotor's angle Θ, the molecule's helix and the record's "helicene pitch" (SR-102, L449–L450; SA-20) are never a strand of 0.1d or a stroke of I-2. The open stroke's $\pi/4$ is the equality of its two rates, which only the open stroke has at every frequency (I-2); a closed pattern's strand at pitch $\vartheta = \pi/4$ is the strand at which 0.1d's rectangle of the two readings is largest. The record's "Archimedean screw", "turbine", "wind" and "blade" stay its analogies (SR-031, L238–L242; SR-449, L2448; SR-642, L3888–L3889; SA-01, SA-77, SA-105). Invariants: 0.1d, I-2, I-4, I-5. Precision: the record prints the helix as two-turn and no pitch value; the reading carries no number. Falsifier: the twist reading of the helix is put to test by T-1 and T-2, whose exclusion rules name the sizes they exclude. Standing: a re-description at quoted clauses; it corroborates no invariant.

Cluster 2: chirality carries a flow direction (P-4). In this analysis's reading the helicene's hand is one carrier of the cone's flow direction, which P-4 calls intrinsic and "not the local velocity in the overlap region". The record's sign rule is the model's: "Reversing the current direction changes the sign of this work" and "the opposite helicene enantiomer would change the sign of this work for the same electron current direction" (SR-274, L1241–L1242; SR-275, L1242–L1243; SA-46), and "For a molecule with the opposite chirality, the contour is traversed in the opposite direction" (SR-164, L634–L635; SA-30). The material is "a racemic mixture" (SR-221, L1013–L1014; SR-337, L1988; SA-39), so no hand dependence was measured; the measured fact is that the cyclic sequence of current levels reverses with the bias polarity, "inverted to A $\rightarrow$ C $\rightarrow$ B $\rightarrow$ A" (SR-048, L284; SA-05, SA-07), a statement in label space whose labels the record sets by current rank (SR-043, L275–L277). The record's "left" and "right" are its schematic's sign convention (SR-620, L3719–L3720; SA-101), never a stereodescriptor. P-4's attraction–repulsion rule is not applied to the molecule–current pair: its magnitudes are I-1 derivations with a declared kernel, and no sign is written for a pair a many-cone settlement does not join (O-5). The anthracene control removes chirality together with the helix, the heteroatoms and the side groups (SR-114, L476–L477; SR-436, L2399–L2400; SA-22, SA-76). Invariant: P-4 as concept anchor. Precision: none printed; the inversion is shown for the junction of Fig. 1 (SA-05). Falsifier: T-1 and T-2 read the hand directly, in resolved enantiomers. Standing: re-description; it corroborates no invariant.

Cluster 3: the model's coupling-plane area (0.1d, I-3a). 0.1d writes "A pattern at rest has $\mathbf{P} = mc^2\mathbf{\Sigma}$, a pure bivector: rest energy is circulation, an oriented area", and I-3a splits the deviation map into "an antisymmetric part (vorticity: the bivector grade, the mechanical circulation whose magnetic projection is that of P-5)". The record calculates that "The total work performed by this torque per rotation is proportional to three times the area integral of the function (ignoring small differences between A, B, and C)" (SR-161, L625–L628; SR-162, L628–L632), that "For a non-chiral molecule, it collapses into a line with zero area" (SR-163, L632–L634), and that for the opposite chirality the work is negative (SR-165, L635; SA-30, SA-39). In this analysis's reading that area lies in the model's coupling plane of $(\mathsf{t}_\mathrm{L}, \mathsf{t}_\mathrm{R})$ (SR-292, L1322–L1323; SR-293, L1335), neither 0.1d's unrolled strand plane nor I-3a's deviation map of a family of patterns, so neither clause is applied to it. The equality of the loop integral and the area integral is Stokes's theorem on two couplings (SA-49) and holds in every theory; the loop is the model's heuristic path (SR-626, L3778; SR-627, L3779; SA-102). Invariants: 0.1d and I-3a, named and not applied. Precision: the record's "three times" is approximate, "ignoring small differences between A, B, and C" (SR-162, L628–L632). Falsifier: none is owed; the equality is algebra. Standing: identity map; it corroborates no invariant.

Cluster 4: twist and magnetism (P-5, 0.1c). P-5 and the helical window are quoted in the framework. In this analysis's reading the helicene's helix is P-5's "helical geometry", a twist that establishes a magnetic field, the field B_tw of the helicene. The core assigns neither its value nor the

map from hand to sign: "Quantitative twist → moment forms are derived in-manuscript through I-1/I-2 with a declared kernel", and this analysis writes neither that kernel nor the map from a circulating charge to an I-1 input (O-6). T-1 and T-2 carry the reading as existence predictions. The record's outlook keeps its subject and modal: "Coupling such rotors to circularly polarized light or spin-polarized currents" "could enable optical or spin-dependent control" (SR-177, L672–L673; SR-178, L673; SA-33), its "light" the record's word. The SI's "Lorentz" force, added "explicitly, since it may arise from current-induced forces" (SR-531, L2905–L2906), with "no contribution from the 'Lorentz' force" to the axial equation (SR-534, L2936; SA-92), stays the record's; its field is $\mathcal{B}_{\mathrm{Lor}}$, kept apart from B_{tw} and never called a magnetic field. Invariants: P-5, 0.1c. Precision: no value is assigned. Falsifier: the exclusion rules of T-1 and T-2. Standing: the reading is the ground of two predictions; it corroborates no invariant.

Cluster 5: one carrier, driven observables, work over an angle (I-1, I-2). In this analysis's reading the electrodes' phonons and the molecule's vibrations, the record's "phonon modes in Au atomic junctions" and its "phononic contribution stemming from vibrational mode coupling to the electrodes" (SR-207, L949–L950; SR-264, L1212–L1213; SR-539, L2960–L2961; SA-37, SA-44, SA-93), are I-2's one carrier at different density and geometry regimes; the A-5 token names those regimes and ranks nothing. In this analysis's reading the record's wind torque, "only non-zero in the nonequilibrium situation" (SR-269, L1234–L1235; SA-46), vanishes at zero drive as I-1's driven observables do, while the record's "conservative torque derived from the equilibrium electronic potential energy surface" (SR-259, L1199–L1200) stays the record's and is not an I-1 pair force. I-1's "Force × length = energy", in angular form, makes a torque integrated over an angle a work. The record's "(or angular momentum transferred)" (SR-271, L1236; SA-46) is its own slip, a work and an angular momentum differing in dimension; its escape time, which writes $\mathcal{N}_{\mathrm{w}}$ where Supplementary Eq. (4) writes the energy $\mathsf{g}_{\mathrm{w}} e\mathcal{V}$ (SR-667, L4022; SR-384, L2218; SA-110), is its own form, a torque and an energy sharing one dimension; neither enters this analysis's equations. The rotation rate is a rate ("rate ≠ force"), fitted by the record's "Arrhenius-like expression" (SR-090, L412; SA-15). The rotor's gravitational window, $\alpha_{\mathrm{ext}} = 2.5\times10^{-42}$ at $r_f = 1.0$ nm for the bound molecule's mass (U-10, U-12; SA-113), is the small number that "is a correct reading (I-1)" (0.1c). Invariants: I-1, I-2. Precision: the window carries the two figures of its inputs. Falsifier: the pair force consensus physics calls gravity, measured between laboratory patterns and departing from the closed form, would contradict Eq. (2) on its domain; the record measures none. Standing: re-description; it corroborates no invariant.

Cluster 6: the quantum face and the classical limit (I-4). The record's Landauer–Büttiker transport and torques, computed on its own inputs (SR-248, L1155–L1156; SR-279, L1255–L1256; SR-590, L3208; SA-45, SA-47, SA-98), are the identity map. Its angle "is treated classically, while the electronic environment that couples to the mechanical" motion "is treated quantum-mechanically" (SR-255, L1185–L1186; SR-256, L1186; SA-43); in this analysis's reading the classical angle and the quantum-mechanically treated electrons are one statement read in two limits, as I-4 reads its four forms, and the split is the record's method. The record states "$\mathcal{L}/\hbar \sim 100 \gg 1$" (SR-258, L1194); its stated inputs, $\mathcal{I}/\hbar \approx 3 \times 10^{-9}$ s and $\mathfrak{V}_0 \approx 10$ meV (SR-529, L3019; SA-94), give, for the rotor whose kinetic energy equals the barrier height $2\mathfrak{V}_0$ (SR-549, L3007), $2(\mathfrak{V}_0\mathcal{I})^{1/2}/\hbar \approx 4 \times 10^2$ at one figure, and its simulation's $\mathcal{I} = 5$ eV ps^2 and $\mathfrak{V}_0 = 5$ meV (SR-286, L1297; SR-288, L1307) give 5×10^2; the conclusion $\mathcal{L} \gg \hbar$ holds either way. The record's "stochastic" (SR-375, L2177; SA-64) stays its modelling word; in FDT's voice the junction is deterministic, and in this analysis's reading the measured dwell distribution is the spread of initial data that no apparatus fixes (I-4). Invariant: I-4. Precision: one figure. Falsifier: none beyond the record's own; the ratio is the record's estimate. Standing: identity map; it corroborates no invariant.

Cluster 7: nodal channels and clamps (P-2, P-3). In this analysis's reading the HOMO and HOMO−1 "derived mainly from p state on the terminal sulfur atoms" (SR-148, L574; SR-610, L3627–L3628; SR-611, L3630–L3631; SA-28, SA-100) are nodal patterns of the driven density field whose geometry the clamps set, the Au apex and the sulfur nuclei as P-3's pinning sites, and the rotation that rearranges the clamps shifts the resonances, which "shift to higher energies when moving from 0° to 60°" (SR-492, L2678–L2679; SA-87). The values are calculated. Each clamp nucleus carries two charts, declared in the system chart table: an exterior compactness of order 10^{-38} and the schematic $\alpha_{\mathrm{core}} \to 1^{-}$ at its skin. Invariants: P-2, P-3 as anchors; I-3 for the two charts. Precision: none; the values are model numbers. Falsifier: none is owed. Standing: re-description; it corroborates no invariant.

Cluster 8: every channel once (I-7, 0.5). Equation (9) enters the rotor's rest mass in M, its rotational kinetic energy in E/c^2, the wind work per turn and the heat it leaves in the electrodes in E/c^2 once, the bias's electrostatic energy in E/c^2, and the thermal term with $a = 4\sigma_{\mathrm{SB}}/c$ at the junction temperature the record assumes (SA-18). The thermal term is 2.1×10^{-56} kg at 4.2 K, of order 10^{-32} of the rotor's mass. Invariant: I-7. Precision: two figures, those of the 4.2 K bath (SR-225), at the declared volume (U-14). Falsifier: a channel entered twice; none is. Standing: bookkeeping; it corroborates no invariant.

Cluster 9: the identity map on the record's numbers (Use item 2). On the record's own inputs FDT returns the record's values save the steady rotation, which the record prints as an angular velocity and, at about the same value, as a frequency (SR-661, SR-684), and the lower end of the slope range in the record's main text, which Table S2 does not print (SR-096, SA-17); the rows below recompute them, and none corroborates an invariant. The Arrhenius fits and Table S2 (SA-15, SA-66, SA-67, SA-68, SA-69), the dwell fits (SA-64), the bounds of SA-71 to SA-74, the critical ratio (SA-96), the 42 K estimate (SA-104), the DFT values (SA-14, SA-28, SA-82 to SA-90) and the simulations (SA-31, SA-106, SA-107, SA-111, SA-112) all stand on the record's inputs.

record value	recomputation	result	rows
E_{b} of set-1 at an assumed 4.2 K	$32.1\,k_{\mathrm{B}} \times 4.2$ K	11.62 ± 0.07 meV (Table S2 prints 11.62 ± 0.09)	SR-392, SR-394
g_{w} of set-1 at 4.2 K	$41.6\ \mathrm{V}^{-1}\,k_{\mathrm{B}} \times 4.2\ \mathrm{K}/e$	1.51 ± 0.03 % (Table S2 prints 1.51 ± 0.04)	SR-381, SR-396
$E_{\mathrm{b}}/(e\mathsf{g}_{\mathrm{w}})$ of set-1	32.1/41.6	0.77 ± 0.02 V	SR-393
backward-to-forward ratio at 420 mV	$\exp(-2 \times 63.0\ \mathrm{V}^{-1} \times 420\ \mathrm{mV})$	1×10^{-23}	SR-416, SR-417, SR-418
backward waiting time	$1/(2.7\ \mathrm{Hz} \times 1 \times 10^{-23})$	4×10^{22} s	SR-418, SR-421, SR-423
barrier-asymmetry bound	$\ln(4 \times 10^{22})$	$52\,k_{\mathrm{B}}T$	SR-423, SR-425
critical torque-to-friction ratio	$\frac{\sqrt{2}}{3} \cdot \frac{8\sqrt{2}}{3} \big/ \frac{4\pi}{3}$	0.42	SR-564
junction temperature of the model	$144/40 \times 11.6$ K	$\approx 4 \times 10^{1}$ K	SR-638, SR-640
junctions with three or more levels	$86 + 25 + 11$	122	SR-364, SR-052
all junctions of Table S1	$194 + 86 + 25 + 11$	316	SR-364, SR-362
LUMO estimate of the molecule in solution, from cyclic voltammetry and the onset of the longest wavelength absorption; "the frontier orbital energies of the molecule will change once it is attached to the metal (Au) in the junction" (SR-306, L1723–L1724; SA-53)	$-5.00 + 2.72$	-2.28 eV	SR-304, SR-302
HH barrier reduction	1.6/0.4	4	SR-475, SR-476
$k_{\mathrm{B}}T$ of the simulation	$2\ \mathrm{meV}/k_{\mathrm{B}}$	2×10^{1} K	SR-659
steady rotation $\dot{\Theta}_{\mathrm{s}} \simeq 71$ GHz read as an angular velocity	$71 \times 10^{9}/(2\pi)$	11 GHz	SR-661, SR-684

Three of the record's numbers stand against a second print: an approximate pair at its own figures, a rotation printed as an angular velocity and as a frequency, and a range end Table S2 does not print: the survival current "$\sim$ 52 µA" (SR-132, L530–L531) against "$\sim$ 50 µA" in the caption (SR-186, L889), the steady rotation "$\sim$ 70 GHz" printed as a frequency (SR-684, L4094–L4095) against the angular velocity $\dot{\Theta}_{\mathrm{s}} \simeq 71$ GHz (SR-661, L4001; SA-107), and the slope range whose lower end "23" (SR-096, L423) is absent from Table S2, whose least value is 32 ± 1 (SR-381, L2239; SA-17). The text's "Table S1" for the list of $E_{\mathrm{b}}/(e\mathsf{g}_{\mathrm{w}})$ is Table S2 (SR-442, L2429). The pull–push traces are taken at 50 mV in the text (SR-325, L1969–L1970) and at 100 mV in the Fig. S5 caption (SR-344, L2024; SA-54). The Methods' potential $\mathfrak{V}_0 \cos 3\Theta$ (SR-288, L1307) and the SI's $-\mathfrak{V}_0 \cos 3\Theta$ (SR-523, L2989; SA-48) differ by an angle origin shifted by $\pi/3$. The counts are the record's: 316 junctions of an unstated total (SR-050, L286–L287; SA-63), 122 with three or more levels, 194 with two (SR-363, L2124), 321 in the displacement histograms (SR-110, L469–L470), 280 in the shoot-up histogram (SR-451, L2456), and 129 junctions in the text against 92 in the caption of Fig. 3 (SR-130, L525–L526; SR-209, L960–L961); the junction's molecule is identified by its conductance and its inelastic steps, and its structure was analysed only on a sample sublimed outside the junction (SA-113). The record's "100%" is a count over finitely many observed jumps (SA-08), and its backward-hop ratio is a model estimate conditional on "unless the unbiased molecule shows very different probabilities for turning left vs. right" (SR-

419, L2333–L2334; SA-74). Invariant: Use item 2, the identity map on the record's own inputs and dictionary. Precision: each result at the figures its inputs license, a stated input error propagated to its result. Falsifier: a recomputed central value that misses the record's printed value at its printed figures; none does but the steady rotation, which the record prints as an angular velocity and, at about the same value, as a frequency (SR-661, L4001; SR-684, L4094–L4095; SA-107). Standing: identity map; it corroborates no invariant.

Cluster 10: the temperatures (0.1c, SA-18). The bath is 4.2 K (SR-225, L1026–L1027); the record's 20 K is "a conservative estimate" used "as an input" (SR-098, L429), and its 42 K is a model estimate, "of the same order as the junction temperature of 20 K" (SR-640, L3882–L3883; SR-641, L3883–L3884). The junction temperature is an assumed input: this analysis reads it as no clock's rate, and the fitted dimensionless barrier $E_\mathrm{b}/k_\mathrm{B}T$, which the fit returns "without assuming an effective molecular temperature" only in its ratio to the slope (SR-399, L2247), stays a fitted combination (SA-15). Invariant: 0.1c's medium window, whose conditions are not stated for the junction. Precision: the record's figures. Falsifier: none is owed. Standing: re-description; it corroborates no invariant.

4 Cone-position translation

In this analysis's reading the record's vocabulary maps onto the density cones of P-4 and the helices of 0.1d and I-2 as follows; the A-4 cone-position token carries no value (O-3), so the translation assigns no position on any axis.

record term	FDT term	kept apart
electrons crossing the junction	$n = 3$ closures on helical geodesics of truncated density cones (I-4, I-5)	no address, no cone position (O-9, O-3)
helical molecule, "two-turn"	a helical geometry, a twist in the sense of P-5	never a strand of 0.1d or a stroke of I-2
helicene hand	one carrier of a cone's flow direction (P-4)	no attraction or repulsion sign assigned
rotor angle and rate	the turning of an extended pattern about its axis	never a strand's circulation
"pitch" of the helicene	the molecule's geometric pitch at an electrode separation	never 0.1d's ϑ, never I-2's $\pi/4$
phonons and molecular vibrations	the one carrier of I-2; the A-5 token	no ranking of regimes
"Lorentz" force	the record's velocity term $\mathcal{B}_\mathrm{Lor}$	never the twist field B_tw
torque-work loop area	Stokes's theorem in the coupling plane	neither 0.1d's strand plane nor I-3a's deviation map

5 Predictions

Five predictions follow, T-1 to T-5, each a statement that general relativity and quantum mechanics do not make: FDT supplies an additional source, the twist field of P-5 (T-1, T-2), or a constitutive input, the density channel of I-7 (T-3 to T-5) (Use item 2). No candidate is retired. The common design of all five is sixteen cooldowns of the record's break junction (SR-225, L1026–L1027), eight per arm, one arm per cooldown from the local heated molecular source (SR-232, L1054–L1055), the arm of each cooldown fixed by a balanced random permutation drawn before the first cooldown; that randomisation makes the permutation test exact [2]. The statistic is the difference of the arms' mean cooldown values, against all $\binom{16}{8} = 12{,}870$ balanced relabellings (U-17). A two-sided test at level 0.0027 rejects when the observed statistic is among the 34 largest in magnitude, exact size 0.00264; a one-sided test at level

0.00135 rejects when it is among the 17 most extreme in its direction, exact size 0.00132 (U-18). Every executed rate below comes from 2×10^4 Monte Carlo trials of the full design (U-19).

5.1 T-1: a field-odd zero-bias conductance with a hand-odd part

This block carries DC-1 and discriminates SA-24, the zero-bias differential conductance that "identifies the characteristic conductance of helicene junctions" (SR-125, L519; SR-126, L520); its warrant is P-5, an additional source, through the sentence "Imposing a physical twist (torsion, helical geometry) on a material *is* establishing a magnetic field".

Arms, field and observable. The arms are enantiopure (P)- and (M)-dithioacetyl[13]helicene resolved from the record's racemate (SR-221, L1013–L1014; SA-39) by chiral chromatography (external; U-26), five junctions per cooldown. The field is an axial field of ± 1 T along the electrode axis from a superconducting solenoid (external; U-20), reversed forty times per junction in ABBA order. The observable $\mathcal{Y}_{\mathsf{B}}$ is, per junction, the field-odd asymmetry of the zero-bias differential conductance measured by the record's lock-in method (SR-242, L1097–L1099; SR-244, L1105–L1106), averaged over the reversals, and per cooldown the mean over its junctions, with $\mathcal{G}$ the zero-bias differential conductance and $\mathsf{B}_{\mathrm{app}}$ the applied field:

$$\mathcal{Y}_{\mathsf{B}} = \frac{\mathcal{G}(+\mathsf{B}_{\mathrm{app}}) - \mathcal{G}(-\mathsf{B}_{\mathrm{app}})}{\mathcal{G}(+\mathsf{B}_{\mathrm{app}}) + \mathcal{G}(-\mathsf{B}_{\mathrm{app}})}; \tag{10}$$

the statistic Δ_{B} is its mean over the (P) cooldowns less its mean over the (M) cooldowns.

FDT input. In this analysis's reading the helicene's twist field B_{tw} is part of B, "the twist's magnetic field where they sit" (0.1c), and does not reverse with the solenoid, so the zero-bias conductance is not even in $\mathsf{B}_{\mathrm{app}}$; mirror images carry opposite twist fields, so $\mathcal{Y}_{\mathsf{B}}$ has a hand-odd part and $\Delta_{\mathsf{B}} \neq 0$. The prediction is one of existence and is conditional by construction: the core supplies the twist but not its moment kernel, nor the map from a circulating charge to an I-1 input (O-6).

Comparator. The consensus value is zero hand contrast, $\Delta_{\mathsf{B}} = 0$. Two-terminal reciprocity, the linear conductance unchanged when every magnetic field is reversed [3, 4, 5], holds junction by junction (U-15); the mirror maps a (P) junction at $+\mathsf{B}_{\mathrm{app}}$ onto an (M) junction at $-\mathsf{B}_{\mathrm{app}}$; field-odd instrumental offsets (solenoid remanence, thermovoltages, lock-in phase) are common to both hands and cancel; and every reading is taken at the DC bias at which the junction's DC current vanishes, which removes the leading consensus term odd in both field and hand, a DC offset carried through the second-order, magnetochiral conductance [6] (U-16).

Statistic, precision and executed rate. The statistic is the two-sided permutation test of the common design, rejection at level 0.0027 (exact size 0.00264; U-18). The cooldown values are independent between cooldowns; the reversal and junction terms average within a cooldown and the common offset, identical in both arms, cancels in the difference. At per-reversal noise 0.01, junction term 0.002, cooldown term 0.001 and common offset 0.002 (U-21), the difference of arm means has standard deviation $\mathrm{sd}(\Delta_{\mathsf{B}}) = 7.6 \times 10^{-4}$, so a contrast is detected near $3\,\mathrm{sd}(\Delta_{\mathsf{B}}) = 2.3 \times 10^{-3}$. Executed: false-rejection rate 0.00245 in 2×10^4 trials (Monte Carlo error 0.00035) at that noise.

Decision rules. Detection: level 0.0027 (U-18). Exclusion: a hand contrast of 6×10^{-3} in the asymmetry (U-22) is excluded when one-sided permutation tests find, at level 0.00135 (U-18), the measured contrast below zero, each (P) cooldown less that size, and above zero, plus it (executed with no hand effect: 0.99950, Monte Carlo error 0.00016). Attribution: a detection is read as the twist's field when the material left in each cooldown's heated source (SR-232, L1054–L1055), recovered at warm-up,

shows by chiral chromatography an enantiomeric excess of at least 95 % (external; U-26), the reversal-even part of the conductance agrees between the hands within three times its hand difference's error, and the contrast at 0.5 T, from forty further reversals at ±0.5 T in ABBA order in each junction after its ±1 T set, is half that at 1 T within three times their difference's error (U-20, U-39).

Channels. The comparison is a pair of mirror patterns at one point, built so that the consensus deviation cancels (Use item 7):

channel	in the applied field	in the hand	in Δ_{B}
linear conductance under reciprocity	even	even	zero
instrumental offsets	odd	even	cancels
magnetochiral second-order term	odd	odd	removed at zero DC current
twist field of the helix, B_{tw}	does not reverse	odd	remains

Status and ablation. Prospective; existence, conditional by construction. With the twist field in place the prediction is a nonzero hand contrast, encoded +1; with that input set to its consensus value, zero hand contrast, the encoding is −1; their difference, 2, exceeds the sign threshold 1.

5.2 T-2: a magnetization-odd zero-bias conductance with a hand-odd part

This block carries DC-2 and discriminates SA-33, the record's outlook that coupling the rotors to "spin-polarized currents" "could enable optical or spin-dependent control" (SR-177, L672–L673; SR-178, L673); its warrant is P-5, an additional source, as in T-1, with the held-moment sentence of 0.1c.

Arms, electrodes and observable. The arms are those of T-1, five junctions per cooldown, in a break junction cut from a notched nickel wire (external; U-23); both tips are magnetized together along the wire axis by a ±0.5 T pulse and the applied field is then returned to zero, twenty reversals per junction in ABBA order. The observable $\mathcal{Y}_{\mathfrak{M}}$ is the asymmetry of the zero-bias differential conductance between the two remanent magnetizations $\pm\mathfrak{M}$ of the tips at zero applied field, with $\mathfrak{M}$ the tips' magnetization, taken at the DC bias of T-1 and averaged as in T-1:

$$\mathcal{Y}_{\mathfrak{M}} = \frac{\mathcal{G}(+\mathfrak{M}) - \mathcal{G}(-\mathfrak{M})}{\mathcal{G}(+\mathfrak{M}) + \mathcal{G}(-\mathfrak{M})}; \tag{11}$$

the statistic $\Delta_{\mathfrak{M}}$ is its mean over the (P) cooldowns less its mean over the (M) cooldowns.

FDT input. In this analysis's reading the injected electrons' held moments, polarized by the tips, cross the twist's field, which changes along the junction axis z at the molecule's two ends, and "patterns whose held and induced moments, summed per unit $\mathcal{E}$, differ along $\partial_z \mathsf{B}$ fall differently where they sit" (0.1c); the twist field does not reverse with the tips, so $\mathcal{Y}_{\mathfrak{M}}$ has a hand-odd part and $\Delta_{\mathfrak{M}} \neq 0$. Existence only, as in T-1, the core supplying neither the moment kernel nor the map from a circulating charge to an I-1 input (O-6).

Comparator. The consensus value is zero hand contrast. Two-terminal reciprocity with every field and every magnetization reversed together (U-15) makes the zero-field linear conductance even in the tips' magnetization junction by junction, the tips' stray field reversing with them, except for the laboratory field, which the pulse does not reverse: it adds a magnetization-odd term even in the hand, and it and the domain differences between the two remanences are common to both hands.

Statistic, precision and executed rate. The statistic is that of T-1. At per-reversal noise 0.01, a remanent-domain term 0.005 per junction (every pulse repeats one field history, so the remanences' difference is the junction's and is never re-drawn per reversal), junction term 0.002, cooldown term 0.001 and common offset 0.003 (U-24), the difference of arm means has $\mathrm{sd}(\Delta_{\mathfrak{M}}) = 1.4 \times 10^{-3}$ and $3\,\mathrm{sd}(\Delta_{\mathfrak{M}}) = 4.2 \times 10^{-3}$. Executed: false-rejection rate 0.00250 in 2×10^4 trials (Monte Carlo error 0.00035).

Decision rules. Detection: level 0.0027 (U-18). Exclusion: a hand contrast of 8×10^{-3} in the asymmetry (U-25) is excluded when one-sided permutation tests find, at level 0.00135 (U-18), the measured contrast below zero, each (P) cooldown less that size, and above zero, plus it (executed with no hand effect: 0.901, Monte Carlo error 0.002). Attribution: a detection is read as the twist's field when the material left in each cooldown's heated source, recovered at warm-up, shows by chiral chromatography an enantiomeric excess of at least 95 % (U-26), and the reversal-even part of the conductance agrees between the hands within three times its hand difference's error.

Channels.

channel	in the magnetization	in the hand	in $\Delta_{\mathfrak{M}}$
linear conductance under reciprocity, stray field included	even	even	zero
laboratory field, not reversed by the pulse	odd	even	cancels
remanent-domain differences	odd	even	cancels
held moments across $\partial_z \mathsf{B}_{\mathrm{tw}}$	odd	odd	remains

Status and ablation. Prospective; existence, conditional by construction. The encoding is that of T-1: $+1$ with the twist field in place, -1 with zero hand contrast, difference 2 against the sign threshold 1.

5.3 T-3: the isotope shift of the fitted rotation barrier

This block carries DC-3 and discriminates SA-16, the dimensionless barrier of the record's "Arrhenius-like expression" for the rotation rate (SR-090, L412; SR-091, L413), whose $E_{\mathrm{b}}/k_{\mathrm{B}}T$ is minus the fitted intercept: "The first term defines the intercept at zero bias" (SR-390, L2230); its warrant is I-7, a constitutive input, through Discipline 2 and the Discriminator quoted in the framework, whose scope, "purely density-coupled equilibrium observables", this rate-fit barrier is not.

Arms and observable. The arms are perdeuterated dithioacetyl[13]helicene, every hydrogen position, by the record's route from deuterated precursors (external), at an isotopic purity of at least 98 % D by mass spectrometry (U-27), and the protiated molecule; fifteen junctions per cooldown with complete rate fits by the record's cycle counting (SR-379, L2201–L2202) and Supplementary Eq. (5), $\mathcal{R}_0 = 10^{10}\ \mathrm{s}^{-1}$ as the record fixes it (SR-403, L2259). With $O_3 = E_{\mathrm{b}}/k_{\mathrm{B}}T$, minus the fitted intercept and carrying the threshold term of SA-65, at the 4.2 K bath (SR-225, L1026–L1027), the observable is per cooldown the mean of $\ln O_3$; with Δ the finite isotope change, the bar the mean over an arm's cooldowns and the labels perd and prot the perdeuterated and the protiated arm, the statistic is

$$\Delta \ln O_3 = \overline{\ln O_3}^{\,\mathrm{perd}} - \overline{\ln O_3}^{\,\mathrm{prot}}. \tag{12}$$

FDT input. The block writes the finite isotope change of an observable O over the density channel and each comparator channel, with x_i the inputs of the channels and S_i their sensitivities, each the derivative of $\ln O$ with respect to $\ln x_i$ with every other input held fixed:

$$\Delta \ln O = \sum_i S_i \, \Delta \ln x_i, \qquad S_i = \frac{\partial \ln O}{\partial \ln x_i}. \tag{13}$$

The density channel's input is the rotor's own compactness on the A-1 chart, exterior branch, the object the bound rotor at the declared $r_f = 1.0$ nm (U-10, U-12), moved by the substitution at fixed P, r and packing (I-3 chart discipline 5): $\Delta \ln \alpha_{\mathrm{ext}} = \Delta \ln \mathcal{M} = 0.0626$ for the bound rotor's sixty-four deuterons (U-28), with the masses of AME2020 [10]. The block is conditional by construction: its input sign is the Discriminator's, its observable sign is $\mathrm{sgn}(\prod_i S_i)$, and the density channel's sensitivity is not established; this analysis reads "larger response" as a larger $E_\mathrm{b}/k_\mathrm{B}T$, its own reading. In the braid reading each isotopic nucleus is one pattern and each mass a confinement eigenvalue (I-5, 0.1b); the proton is an $n = 3$ closure, and the deuteron's helix count is not assigned; no mass formula, anchor or address enters.

Comparator. The Born–Oppenheimer barrier is unchanged by the substitution. The attempt frequency's inertia channel is not: its true value scales as a power of the moment of inertia between $-\frac{1}{2}$, the transition-state limit, and -1, the energy-diffusion limit [7, 8] (U-30), near which the record's friction estimate places the rotor, "$\eta/\hbar \approx 1$" against "$(\mathcal{I}/\hbar)(\mathfrak{V}_0/\hbar)$" under a root "$\approx 10^2$" (SR-556, L3045–L3046; SR-557, L3047). With $\mathcal{R}_0$ held at the record's value, the fitted $E_\mathrm{b}/k_\mathrm{B}T$ rises by $\frac{1}{2}\Delta \ln \mathcal{I}$ to $\Delta \ln \mathcal{I}$, with $\Delta \ln \mathcal{I}$ from 0.06 to 0.14 for perdeuteration (U-29, U-31), over the record's values from 32.1 to 67 (SR-392, L2238): $+0.0004$ to $+0.0044$ in $\Delta \ln O_3$. The barrier's zero-point change contributes ± 0.01 and the friction prefactor ± 0.002 (U-31). The junction's effective temperature, which the fitted dimensionless barrier divides (SR-400, L2247–L2248) and the record does not measure (SA-18), enters with sensitivity -1, its isotope change bounded at ± 0.05 by the friction's isotope change (U-31). Joined and rounded outward to 0.01 (U-31), the comparator interval is -0.07 to $+0.07$.

Channels.

channel	input under perdeuteration	sensitivity	contribution
density, α_{ext} (A-1)	$+$	conditional	$+$ in this reading
inertia of the attempt frequency	$+\Delta \ln \mathcal{I}$	$+\frac{1}{2}(E_\mathrm{b}/k_\mathrm{B}T)^{-1}$ to $+(E_\mathrm{b}/k_\mathrm{B}T)^{-1}$ (U-31)	$+$
zero-point barrier change	either sign	bounded	$\pm$
friction prefactor	either sign	bounded	$\pm$
effective temperature	either sign	-1 (U-31)	$\pm$

Statistic, precision and executed rates. The statistic is the one-sided permutation test of the common design, FDT sign positive, with the comparator's upper end subtracted from the perdeuterated cooldowns, rejection at level 0.00135 (exact size 0.00132; U-18). At a junction standard deviation of 0.30 in the logarithm (U-32; Table S2's five sets give 0.3 ± 0.1, SR-392), a fit error of 0.02 and a cooldown term of 0.05 (U-32), the difference of arm means has $\mathrm{sd}(\Delta \ln O_3) = 0.046$, and the block's threshold is $3\,\mathrm{sd}(\Delta \ln O_3) = 0.14$. Executed at the upper end: false-rejection rate 0.00115 in 2×10^4 trials (Monte Carlo error 0.00024); at the centre no trial rejects, a rate below 0.00005.

Decision rules. Detection: level 0.00135 (U-18), one-sided. Exclusion: an FDT-sign residual of 0.35 in the logarithm (U-32) above the comparator's upper end — on any comparator value, a density-channel contribution of that size plus the comparator's width — is excluded when the one-sided test in

the negative direction, of the difference minus the upper end minus that size, rejects at level 0.00135 (U-18; executed with no density channel: 0.99910 at the upper end, Monte Carlo error 0.00021, and every trial at the centre). Attribution: a detection is read as the density channel when the perdeuterated material meets its purity, each cooldown's $1\,\mathcal{G}_0$ Au peak agrees between the compositions within 2 % (electrodes alike; SR-340, L1997–L1998; U-35), the C–D stretch step replaces the C–H step between the compositions' inelastic dI/dV (the record's Fig. 3b method, SR-128, L523–L524; external energies, U-36 [12]), and forty-eight further cooldowns, the common design thrice, tert-butyl-d36 (SR-222, L1016; SA-115; external synthesis, at least 98 % D, U-37) against protiated, return an excess over their comparator's centre (this block's channels, U-38) within three combined errors (in quadrature: both excesses' errors, the perdeuterated one's times the ratio applied, each channel's half-width times its ratio's distance from it) of the perdeuterated excess over its centre times both rotors' $\Delta \ln \mathcal{M}$ ratio, 0.570 (SA-113; U-28), and more than three from it times each channel's ratio between them (U-38, from both rotors' structures, else no attribution). In this analysis's own reading, at fixed r_f the density channel's input is $\Delta \ln \alpha_{\mathrm{ext}} = \Delta \ln \mathcal{M}$ (0.3, I-7), one S_i, while the comparator's channels follow where the deuterons sit.

Status and ablation. Prospective; conditional by construction, instantiated at the exclusion rule's test point. With the density channel in place at the residual the rule names, the predicted $\Delta \ln O_3$ is the upper end plus that residual, 0.42; with the density channel at its consensus value, zero, it is the upper end, 0.07; the difference, 0.35, exceeds the block's threshold 0.14.

5.4 T-4: the isotope shift of the molecular conductance peak

This block carries DC-4 and discriminates SA-57, the record's histogram in which "a new wider peak appears at lower conductance" (SR-341, L2006–L2007); its warrant is I-7, a constitutive input, as in T-3, the Discriminator's scope again excluding this transport observable.

Arms and observable. The arms and cooldowns are those of T-3. The observable is per cooldown the logarithm of the most probable conductance of the molecular peak, $O_4 = \mathcal{G}_{\mathrm{peak}}/\mathcal{G}_0$, of a 10,000-trace histogram recorded as the record's pull–push cycles "without data selection" (SR-339, L1994–L1995), at 100 mV (SR-344, L2024; SA-54 carries the text's 50 mV, SR-325, L1969–L1970):

$$\Delta \ln O_4 = \overline{\ln O_4}^{\,\mathrm{perd}} - \overline{\ln O_4}^{\,\mathrm{prot}}. \tag{14}$$

FDT input. The input is that of T-3, Eq. (13) with $\Delta \ln \alpha_{\mathrm{ext}} = 0.0626$ (U-28); this analysis reads the larger response as a higher peak conductance, its own reading.

Comparator. The Born–Oppenheimer transmission is unchanged; its zero-point and vibronic-averaging change is bounded at ± 0.02 in the logarithm (U-33), so the comparator interval is -0.02 to $+0.02$.

Channels. Explicit scope: one comparator channel, the zero-point and vibronic average of the transmission, of either sign and bounded; the density channel enters with the Discriminator's input sign and a sensitivity that is not established.

Statistic, precision and executed rates. The statistic is that of T-3, the comparator's upper end subtracted from the perdeuterated cooldowns, level 0.00135 (U-18). At a peak-fit error of 0.01 and a cooldown term of 0.08 (U-33), $\mathrm{sd}(\Delta \ln O_4) = 0.040$ and the block's threshold is $3\,\mathrm{sd}(\Delta \ln O_4) = 0.12$. Executed at the upper end: false-rejection rate 0.00150 in 2×10^4 trials (Monte Carlo error 0.00027); at the centre 0.00030 (Monte Carlo error 0.00012).

Decision rules. Detection: level 0.00135 (U-18), one-sided. Exclusion: an FDT-sign residual of 0.30 in the logarithm (U-33) above the comparator's upper end — on any comparator value, a density-channel contribution of that size plus the comparator's width — is excluded when the one-sided test in the negative direction, of the difference minus the upper end minus that size, rejects at level 0.00135 (U-18; executed with no density channel: 0.99865 at the upper end, Monte Carlo error 0.00026, and 0.99975 at the centre, Monte Carlo error 0.00011). Attribution: a detection is read as the density channel when the perdeuterated material meets its purity, each cooldown's $1\,\mathcal{G}_0$ Au peak agrees between the compositions within 2 % (U-35), the C–D stretch step replaces the C–H step between the compositions' inelastic dI/dV (SR-128; U-36), and forty-eight further cooldowns of tert-butyl-d36 against protiated (U-37) return an excess over their comparator's centre within three combined errors of the perdeuterated excess over its centre times both rotors' $\Delta \ln \mathcal{M}$ ratio, 0.570 (U-28), and more than three from it times each channel's ratio between them (U-38, else no attribution), the combined errors formed in quadrature as in T-3.

Status and ablation. Prospective; conditional by construction, instantiated at the exclusion rule's test point: with the density channel in place, $\Delta \ln O_4 = 0.32$; at its consensus value, zero, it is the upper end, 0.02; the difference, 0.30, exceeds the block's threshold 0.12.

5.5 T-5: the isotope shift of the shoot-up voltage

This block carries DC-5 and discriminates SA-78, the record's shoot-up voltage, "the applied voltage at which an abrupt current shootup is found" (SR-450, L2454–L2455), with its histogram of 280 junctions (SR-451, L2456); its warrant is I-7, a constitutive input, as in T-3.

Arms and observable. The arms and cooldowns are those of T-3, thirty junctions with a shoot-up per cooldown (U-27). The observable is per cooldown the median of $\ln O_5$, $O_5 = \mathcal{V}_{\mathrm{shootup}}$ as the record defines it, and with $\widetilde{\ln O_5}$ that median and $\overline{\widetilde{\ln O_5}}$ its mean over an arm's cooldowns,

$$\Delta \ln O_5 = \overline{\widetilde{\ln O_5}}^{\,\mathrm{perd}} - \overline{\widetilde{\ln O_5}}^{\,\mathrm{prot}} . \tag{15}$$

FDT input. The input is that of T-3, entering, in this analysis's own reading, through the barrier. In the record's critical relation, $\tilde{\mathcal{N}}_{\mathrm{w}}/\tilde{\eta} > 4/(3\pi)$ (SR-564, L3097–L3098; SA-96), with $\tilde{\mathcal{N}}_{\mathrm{w}} = \mathcal{N}_{\mathrm{w}}/(9\mathfrak{V}_0)$ and $\tilde{\eta} = \eta/[3(\mathcal{I}\mathfrak{V}_0)^{1/2}]$ (Supplementary Eq. (40), SR-689, L3033–L3038), the critical torque scales as $\eta(\mathfrak{V}_0/\mathcal{I})^{1/2}$; the density channel is read as moving the equilibrium barrier $\mathfrak{V}_0$ of "the equilibrium electronic potential energy surface" (SR-260, L1200–L1201), its sensitivity $+\frac{1}{2}$ in the critical torque, and the larger response as a larger $\mathfrak{V}_0$.

Comparator. The inertia channel contributes $-\frac{1}{2}\Delta \ln \mathcal{I} \cdot S_{\mathcal{N}}$, with $S_{\mathcal{N}} = \partial \ln \mathcal{V}_{\mathrm{shootup}}/\partial \ln \mathcal{N}_{\mathrm{crit}}$, the sensitivity of the shoot-up voltage to the critical torque $\mathcal{N}_{\mathrm{crit}}$, between 0 and 1 for a torque proportional, "to a leading order", "to the excess voltage" above a threshold (SR-387, L2222; SR-386, L2221; U-29, U-34): -0.07 to 0. The friction's isotope change contributes ± 0.05 times $S_{\mathcal{N}}$, and the zero-point change of $\mathfrak{V}_0$ ± 0.01 (U-34). The inertia and friction channels carry one $S_{\mathcal{N}}$, and the join takes both at the same value, with $\Delta \ln \mathcal{I}$ over T-3's range (U-29). Joined and rounded outward, the comparator interval is -0.13 to $+0.03$.

Channels.

channel	input under perdeuteration	sensitivity	contribution
density, through $\mathfrak{V}_0$	$+$	$+\frac{1}{2}S_{\mathcal{N}}$, conditional	$+$ in this reading
inertia, through $\mathcal{I}^{-1/2}$	$+\Delta\ln\mathcal{I}$	$-\frac{1}{2}S_{\mathcal{N}}$	$-$
friction	either sign	$S_{\mathcal{N}}$	$\pm$
zero-point change of $\mathfrak{V}_0$	either sign	bounded	$\pm$

Statistic, precision and executed rates. The statistic is that of T-3, the comparator's upper end subtracted, level 0.00135 (U-18). At a junction standard deviation of 0.25 in the logarithm (U-34; Table S2's $E_{\mathrm{b}}/(e\mathrm{g}_{\mathrm{w}})$ spread is 0.26 ± 0.09, SR-393), a median error of $1.2533\times0.25/\sqrt{30}$ and a cooldown term of 0.03 (U-34), $\mathrm{sd}(\Delta\ln O_5)=0.032$ and the block's threshold is $3\,\mathrm{sd}(\Delta\ln O_5)=0.097$. Executed at the upper end: false-rejection rate 0.00150 in 2×10^4 trials (Monte Carlo error 0.00027); at the centre no trial rejects, a rate below 0.00005.

Decision rules. Detection: level 0.00135 (U-18), one-sided. Exclusion: an FDT-sign residual of 0.20 in the logarithm (U-34) above the comparator's upper end — on any comparator value, a density-channel contribution of that size plus the comparator's width — is excluded when the one-sided test in the negative direction, of the difference minus the upper end minus that size, rejects at level 0.00135 (U-18; executed with no density channel: 0.979 at the upper end, Monte Carlo error 0.001, and every trial at the centre). Attribution: a detection is read as the density channel when the perdeuterated material meets its purity, each cooldown's $1\,\mathcal{G}_0$ Au peak agrees between the compositions within 2 % (U-35), the C–D stretch step replaces the C–H step between the compositions' inelastic dI/dV (SR-128; U-36), and forty-eight further cooldowns of tert-butyl-d36 against protiated (U-37) return an excess over their comparator's centre within three combined errors of the perdeuterated excess over its centre times both rotors' $\Delta\ln\mathcal{M}$ ratio, 0.570 (U-28), and more than three from it times each channel's ratio between them (U-38, else no attribution), the combined errors formed in quadrature as in T-3.

Status and ablation. Prospective; conditional by construction, instantiated at the exclusion rule's test point: with the density channel in place, $\Delta\ln O_5=0.23$; at its consensus value, zero, it is the upper end, 0.03; the difference, 0.20, exceeds the block's threshold 0.097.

6 Cross-domain

The two readings that carry the predictions are not peculiar to this junction. The twist reading of P-5 belongs to every helical geometry in a two-terminal conductor: a field-odd or magnetization-odd linear conductance with a hand-odd part, set against the hand-even value that reciprocity fixes (U-15), is the same observable in any enantiopure helical bridge, and the designs of T-1 and T-2 carry over with their comparators. The density channel of I-7 is likewise the same in every isotope pair at fixed geometry: chart discipline 5 makes the substitution move compactness only, so the input $\Delta\ln\alpha_{\mathrm{ext}}=\Delta\ln\mathcal{M}$ has one sign in any rotor or bridge, while the comparator channels, inertia, zero point, friction and effective temperature, are each platform's own and are bounded platform by platform. Both are comparisons in the sense of Use item 7, a mirror pair and an isotope pair at one point, and the record's own anthracene control is a comparison of the same kind with every difference changed at once (SA-22, SA-76). The thermal term of Eq. (9) and the window of the system chart are the same small numbers in any laboratory junction, and they are correct readings there as here (I-1).

7 System-level reading (exploratory)

Scope: this section re-describes one record value in-sample; its observable is labelled X-1, is not a prediction and is not counted with T-1 to T-5.

X-1: the randomness parameter of the hopping regime. Observable: the record's randomness parameter r, which it defines for a stepping motor as twice the effective diffusion coefficient over the mean velocity times the step (SR-569, L3115–L3116; SR-571, L3138–L3139) and bounds, for three inequivalent minima, by $\frac{1}{3} \le \mathsf{r} \le 1$ (SR-576, L3172–L3175; SA-97), without evaluating it on its data. Defining condition: for sequential forward hops out of the three states A, B and C, whose dwell times are exponential with means t_1, t_2 and t_3, the randomness parameter is the sum of the squared mean dwell times over the squared cycle time,

$$\mathsf{r} = \frac{t_1^2 + t_2^2 + t_3^2}{(t_1 + t_2 + t_3)^2}. \tag{16}$$

With the record's mean dwell times at 600 mV, 118 ± 11 ms, 19 ± 2 ms and 7.6 ± 0.6 ms (SR-370, L2160; SR-373, L2173–L2174), $\mathsf{r} = 0.69 \pm 0.03$, in-sample. Comparator: the record's band; the value lies inside it, toward the end the record assigns to hopping "from one of the minima" being "rate limiting" (SR-577, L3178–L3179), here the long-lived state A.

Guards. The value is a re-description of one junction at one bias (SR-370, L2160–L2161), computed from the record's own means; the backward hops it neglects are the record's model estimate (SA-74); the record's "stochastic" stays its word (SA-64); the value is no prediction, and it corroborates no invariant.

8 Convergence statement

The limiting map is the identity on the record's own inputs and dictionary. Given its biases, its counts, its fits, its DFT geometries and its model parameters, FDT returns every value the record prints: the counts of Table S1 and the cyclic order of the levels with its inversion, the Arrhenius fits and Table S2 (SA-15, SA-66, SA-67, SA-68, SA-69), the dwell fits (SA-64), the bounds of SA-71 to SA-74, the critical ratio (SA-96), the 42 K estimate (SA-104), the DFT barriers, transmissions and torques (SA-14, SA-28, SA-82 to SA-90), and the simulated crossover and current rise (SA-31, SA-106, SA-107, SA-111, SA-112), save the steady rotation, which the record prints as an angular velocity and, at about the same value, as a frequency (SR-661, L4001; SR-684, L4094–L4095), and the lower end of the slope range in the record's main text, which Table S2 does not print (SR-096, L423; SA-17); Cluster 9 recomputes the representative values. In the gravitational window containment holds: for the same stress tensor and data FDT returns the curvature of general relativity (I-3), and the junction's window is a small and correct number (I-1). FDT agrees with the data of general relativity and quantum mechanics without reservation.

One reading of the record is declined, once. The record's hopping model gives the rate of hopping "from A to B" and the rate "for hopping to the 'left'" by Arrhenius expressions with one prefactor through the same tilted barriers (SR-405, L2267–L2273; SR-406, L2275; SR-408, L2287; SA-70), the standard reading of a hop and its reverse as mirror events. FDT reads each step as the system-wide, many-to-many settlement of the state it starts from, in which events do not commute and a process run backward is never the mirror of the forward event (0.1a, I-5b); the measured counts and rates are accepted in full.

The divergences are T-1 to T-5, made only where FDT supplies an additional source, the twist field of P-5, or a constitutive input, the density channel of I-7, and never from α, a chart or a branch tag alone.

9 Status ledger

item	status, in the core's words where owed	where it binds here
O-1	owed: "the finite-core cutoff r_c, the regular core chart, or the outward phase-transfer law"	the interior branch of Eq. (4)
O-2	owed: "a geometrically constructed odds for the overlap-contrast application (A-3)"	the A-3 token of SA-13
O-3	owed: "a canonical odds for the confinement application (A-4)"	the A-4 token; the cone-position translation
O-4	owed: "the local profile $\rho_{\mathrm{loc}}(r_f)$ from the omnium constitutive law with boundary, surface and core data, reducing to the measured nuclear profile"	the interior charts of the clamp nuclei
O-5	owed: "multipole and tidal remainders of the closed-form pair expression, and the reading they give of the band $R_H < r_f < R_s$ outside a rotating source's horizon; the overlap complex; how P-4's many-cone settlement signs a pair it does not join"	the molecule–electrode overlap; P-4's rule not applied to the molecule–current pair
O-6	owed: "the maps from a charge, a circulating charge or a colour seat to an I-1 input; derivation of the A_2 seat table from cone geometry; the gluon octet's dynamics"	the twist kernel of T-1 and T-2
O-8	owed: "the constitutive derivation of c_{eff} / n_{cone} and its reconciliation with lensing"	the aperture of P-4, which enters no number
O-9	owed: "the confinement operator D, its domains, boundary data and spectrum; every mass ratio, including the two held-out targets"	Eq. (6) and the braid reading of the isotopes
held-out	held-out target of O-9: the proton-to-electron mass ratio, 1836.15267343	read, never derived
held-out	held-out target of O-9: the squared muon-to-electron mass ratio, 4.2753×10^4	read, never derived
T-1	prospective; existence, conditional by construction, its kernel owed (O-6)	convergence value: zero hand contrast
T-2	prospective; existence, conditional by construction, its kernel owed (O-6)	convergence value: zero hand contrast
T-3	prospective; conditional by construction, the density channel's sensitivity not established	convergence value: the comparator interval -0.07 to $+0.07$
T-4	prospective; conditional by construction, as T-3	convergence value: -0.02 to $+0.02$
T-5	prospective; conditional by construction, as T-3	convergence value: -0.13 to $+0.03$
in-sample	the randomness parameter from the record's three mean dwell times, 0.69 ± 0.03, exploratory section only	no prediction
in-sample	the record's unequal barriers adopted to match its measured dwell times (SR-068, L337; SA-13)	the record's choice, never a test
PROVISIONAL	the A-3, A-4 and A-5 tokens: a range and nothing else, no value, no threshold, no ordering	chart inventory
CONDITIONAL	0.1c's medium clock factor, on a stress tensor of perfect form; not stated for the junction	the record's temperatures stay fit inputs (SA-18)

The abstract's count of predictions is read off the five T-rows above.

10 Conclusions

The record is accepted in full: its switching, its counts, its fits, its calculations and its simulations stand on its own inputs, and FDT returns them save the simulated steady rotation, which the record

prints as an angular velocity and, at about the same value, as a frequency, and the lower end of the slope range in the record's main text, which Table S2 does not print. In this analysis's reading the helicene is a helical geometry in the sense of P-5, its hand one carrier of a flow direction, its electrodes' phonons the one carrier of I-2, and its junction a small, correct gravitational window with every channel counted once. The record's rotation, momentum transfer, chirality rule and stochastic language stay the record's, with their verbs. Where FDT adds a source or a constitutive input, it predicts what the consensus calculation does not: a hand-odd part of the field-odd and magnetization-odd zero-bias conductance in enantiopure junctions (T-1, T-2), and the sign of the density channel in the isotope shifts of the fitted barrier, the conductance peak and the shoot-up voltage (T-3 to T-5), each with its design, its comparator, its exact test and its rules.

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