Entropy

Volume 3: The Progression

Edition 2.5

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Edition 2.5 note

This volume restores the March 2026 text of *The Progression* in its original voice and structure wherever a claim survived the October 2026 second edition, and uses the second edition's substance throughout. Both earlier editions remain intact and unchanged; this text sits beside them. It follows the March six-chapter branch, as the second edition did; a separate structural revision package and an earlier one-chapter draft are not merged.

Four rules govern every line:

- **No withdrawn claim returns.** Where a March sentence carried a claim the second edition withdrew, it is cut, rewritten to the second edition's substance, or quoted only to mark its withdrawal. Each correction points to its row in the correction ledger (V3-L).
- **No analogy becomes evidence.** Analogies are tagged Analogical and mapped term by term in the two analogy tables. Hypotheses are tagged Speculative; testable is not the same as supported.
- **"Favored" is a claim, not a softer word.** It appears only where a model and its alternatives are named. "Attractor" is used technically only where a dynamical model makes the claim explicit.
- **Absence claims are scoped.** Where this volume says something is not established, it means not established by the sources reviewed here, not that no research anywhere bears on it.

No study, protocol or experiment is proposed. Where a chapter says what a test would need, it restates the second edition.

Epistemic tiers

The framework uses four epistemic tiers. A tier is a label for evidence stated next to the claim; the label itself is not evidence.

- **Established:** experimentally verified or mathematically proven, within stated conditions.
- **Supported:** substantial evidence for the stated scope, short of Established.
- **Analogical:** a structural mapping between a physical result and a relational pattern. The physical side keeps its own standing within its stated scope. The mapping can raise questions and help explain, but on its own it does not validate the proposed application; it moves only by the promotion route stated with it.
- **Speculative:** a proposal without independent evidence, for which no conflict with known physics has yet been identified. That is not a proof of consistency.

Collapsing tiers is the framework's cardinal epistemic sin: presenting a Supported claim at Established confidence, a Speculative claim as Supported, or an Analogical mapping as validation of its application.

Conventions and provenance

Reference labels are the second edition's: group P for the physics programs and group Q for the Progression's evidence and limits, listed in full in the references at the end of the volume. Two

supplemental definition notes, D1 and D2, support the biological column of the star-as-host table; they do not renumber the inherited references. Ledger references (V3-L01 to V3-L40) point to the correction ledger. The founding line is mapped in the Volume 1 analogy table. That analogy table is not repeated here.

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Chapter 1: The Problem

A Pattern That Looks Like a Story

> *“Love reduces the entropy of the system and spends more than it saves.” — The Principal, March 17, 2026*

[Analogical; see the Volume 1 analogy table]

This is the most SupoRel-active volume in the series. Every chapter touches the Permission/Necessity slide: the point where a thermodynamic tendency wants to become a thermodynamic necessity. Carroll's aphormeology is the volume's guard — pushed from behind, not pulled toward — as a discipline of explanation, not a proof that the universe has no purpose. The reader should know at every point where the physics stops and the interpretation begins (V3-L01).

Status: This chapter frames a question, not a derived law of cosmic progress. Physical processes constrain the histories described here. A universal rise in complexity, entropy-production rate or relational capacity has not been established by the sources reviewed.

1 The selected sequence

Hydrogen in the primordial plasma. Stars forging heavier elements. Chemistry building molecules. Self-replicating molecules. Cells. Multicellular organisms. Nervous systems. Brains. Language. Institutions. Computation. Artificial intelligence.

The March chapter added that each layer processes more entropy per unit mass per unit time than the last, and that the numbers are watts per kilogram, measured and published (V3-L02). The watts per kilogram are real. They are not entropy. Chaisson's energy rate density, Φ_m, divides a power by a mass. An entropy-production rate per unit mass has units of W/(K·kg), and getting from one to the other takes a physical account of the process, its boundaries and its exchanges, not a change of label [P01, P02; Q14].

The sequence is compelling. It is also selected. Its entries are not stages all matter passes through: stars and microbes still exist alongside computers, many histories contain no life, and many lineages contain no brains. Examples chosen to end at the narrator's present cannot show that the universe as a whole follows their trajectory.

The March line was “The pattern is real. The question is what it means.” The corrected line: the examples are real. Whether they form a pattern, and what it would mean, is the question.

2 Two readings

Reading one: the story. The universe is headed somewhere. Complexity increases because complexity is the point. Life is the universe waking up; consciousness is the universe knowing itself; AI is the next step toward — what? Understanding? Transcendence? The reading is ancient and compelling. The physical findings reviewed here do not establish it.

The March chapter also called this reading structurally identical to the teleological arguments of every major religious tradition, and answered it flatly: the trajectory has no destination. Both go too far (V3-L04). The volume has no experiment or theorem that settles a metaphysical question about purpose, and it need not sort every tradition into one argument to do its own work.

Reading two: constraint without a destination. The March version said the second law guarantees that configurations dissipating gradients more efficiently are more probable, so complexity is a statistically favored configuration (V3-L03). The corrected reading is narrower. Thermodynamics constrains every process in the sequence, and local organization must be counted together with its surroundings. Those constraints do not, by themselves, specify a bacterium, a brain, a relationship or an AI system.

The word “favored” needs care. Favored over which alternatives, under which dynamics, with what resources, over what time? A probability comparison established for one driven model cannot be carried across every rung of the sequence [P03, P04].

This volume still holds the two readings against each other until the difference can be felt. What changes is that reading two must earn its own claims. An account without a destination can still be physically wrong. The physics is real. The story is the capture vector — and so is a physics that claims more than it measured.

3 Why this volume is dangerous

The other volumes describe architectures: how the accounts are kept (Volume 1), what the body records (Volume 2), how substrates compare (Volume 4), what the cosmological inventories are and are not (Volume 5). Volume 3 is a trajectory paper — here is what has happened over time (V3-L39).

Trajectory papers are more dangerous than architecture papers because trajectories look like stories, stories have endings, and endings suggest purposes. Looking back across thirteen billion years of selected examples, the human mind readily generates the hypothesis of a destination.

The March text answered “It does not,” then corrected itself in the next breath: the framework cannot determine whether it does, and the physics does not require that it does. That second sentence is the answer this edition keeps.

The MEPP Assessment Note judged this volume philosophy of physics with physics guardrails, not a physics derivation. That judgment stands (V3-L01). The Seven Categorical Gaps apply to the volume's own claims more stringently than to anything else in the series, as questions each claim must answer, not certificates that it has (V3-L28).

Every claim carries its tier, and a tier is a label for evidence, not evidence. SupoRel's practical test is not how often a warning appears, but whether the claims after the warning stay within their evidence. The reader always knows which floor they are standing on.

4 What the six chapters will do

- **Chapter 2** separates the adjacent research programs — Chaisson, England, Kolchinsky and Wolpert, Still — and the quantities each defines. Their results do not become one theorem because they fit in one diagram (V3-L05, V3-L07, V3-L12).
- **Chapter 3** walks the sequence from atoms to AI. It keeps the concrete observations and examines the comparisons, the missing mechanisms and the limits of the frame-rate analogy (V3-L13, V3-L22, V3-L24).
- **Chapter 4** examines the star-as-host image at the volume's most speculative edge. A memorable image can expose a question. It cannot supply a stellar feedback mechanism or turn conflict into a measured thermodynamic phase transition (V3-L29 to V3-L31).
- **Chapter 5** asks what a process with attractors would mean in a specified model, and keeps that technical use apart from the suggestion that life, intelligence and connection occupy universal basins (V3-L32 to V3-L34).
- **Chapter 6** traces the consequences for the framework's other documents. The revised volumes give consistency within the collection, not independent validation, and dependent papers are not silently revised (V3-L36, V3-L37).

What this chapter now claims

The cosmic context of connection remains worth investigating. The historical sequence does not yet establish a universal progression, a common relational expenditure, or a thermodynamic reason that relational systems must — or generally should — arise.

The work of this volume is to make the proposed bridges visible enough to test. Where a claim fails, the question can survive without the unsupported answer.

Analogy table: The Progression as a ladder

The Progression survives as a selected historical comparison. Reading it as a ladder — rungs climbed in order, one measure rising at each step, a top the climb leads to — is Analogical. The physical column describes what the cited sources establish within their stated scope; that standing does not pass to the ladder reading.

The image comes from March Chapter 2, “Chaisson: The Scale Ladder,” and the March volume's claim that the Progression runs on that ladder.

Term	Physical or historical reading (within stated scope)	Ladder reading	Where the mapping holds	Where it breaks
“rungs”	Distinct kinds of systems chosen as examples: stars, chemistry, cells, brains, data centres.	Stages that matter passes through in order.	Some later examples depend on products of earlier ones; carbon for chemistry is made in helium burning inside stars [Q03].	The entries coexist rather than replace one another, many histories contain no life, and the sequence was selected by a narrator near its endpoint (Ch 1 §1).
“height”	Energy rate density, Φ_m = P/M in W/kg. Rounded examples from Chaisson's 2014–2015 accounts, with their stated boundaries: about 2×10^{-4} for the Sun, 2 for an adult human body, 15 for an adult brain, 50 for human society excluding the mass of its machines [P01, P02].	One quantity, entropy spent per unit mass, rising at every rung.	Within Chaisson's chosen examples and boundaries, Φ_m spans orders of magnitude and is larger for the later examples.	Φ_m is power per mass, not entropy production in W/(K·kg). The boundaries differ, and in the adult resting-energy model evaluated by Wang et al, heart and kidney rates per unit organ mass exceed the brain's [Q06]. The sources reviewed establish no monotonic rise across all systems.
“climbing”	Results for specified driven systems: a lower bound on heat in replication [P03], outcome probabilities in defined driven dynamics [P04], low rattling in robot collectives [P07].	Matter climbs because dissipation favors each next rung.	In those models and experiments, questions about organization become tractable, and outcome probabilities can relate to formation history.	A lower bound is not an origin, “favored” needs a defined comparison, and no source reviewed gives a universal rule that the more complex or more dissipative state wins. “Stabilizes dissipation” would be the same overreach with a new verb (Ch 2 §3).
“the next rung”	The IEA's 2025 report estimates that data centres worldwide used about 415 TWh of electricity in 2024, including non-AI computing and site infrastructure [Q07].	AI as the next layer of entropy acceleration.	Digital computation has real material and energy requirements.	An annual electricity total is not power per mass or entropy production. AI arose through engineering, investment and human choices; “next layer” is a speculative interpretation (Ch 3 §7).
“the top”	A low-entropy past frames the thermodynamic arrow of time [Q01]; explanations from prior conditions need no future goal [P09].	A destination: understanding, transcendence, or, in March Chapter 5, heat death with complexity as a waystation.	Removing a destination still leaves a real arrow of time.	The sources reviewed do not settle cosmic purpose either way, and the argument neither needs nor establishes an unconditional heat-death prediction (Ch 5 §2). Even a demonstrated tendency would carry no mandate (Gap 7).

What the table does not do

It is not evidence for the framework, not a cosmic history and not a ranking of the worth of systems. The physical column keeps its own standing within its stated scope; the ladder reading is Analogical in every row.

Promotion route (conditions, not a work plan)

To move a row from Analogical toward Supported, a study would have to specify the systems and their boundaries, define one quantity measurable across them in comparable units, include the systems that did not develop as well as those that did, and show a stable relation with a stated result that would count against it.

Chapter 6 identifies this missing work without supplying a study. None is proposed here, and no row is promoted.

Chapter 2: The Adjacent Scholarship

Who Has Mapped This Territory

Status: A survey of distinct research programs, not a statement of consensus around the framework. Mathematical results keep their assumptions; empirical findings keep their tested scope. The relational applications remain proposals. SupoRel applies before the synthesis, not only after it.

1 Four frameworks, one question

Four bodies of scholarship map the territory this volume covers. Each illuminates part of the landscape. None provides the relational content the Trinket Soul Framework addresses. The gap is not a criticism; each framework was built for a different question. The gap is an opportunity.

It is not, however, a slot waiting for the framework to fill. The four programs do not jointly establish the Trinket Soul Framework. Their variables, tasks and system boundaries differ, and setting them side by side can reveal a useful question without supplying its answer (V3-L12).

The question worth keeping is concrete: when a physically implemented system responds to another system, which information affects a specified outcome, and what resources does the response use? A relational application must define that outcome rather than assume that staying alive, maintaining a connection, predicting a signal and dissipating energy are the same achievement.

Carroll's aphormeological framing supplies an early guard: explain a process through its prior conditions and dynamics rather than insert a future goal into the explanation. That is a discipline of causal interpretation, not independent evidence for a cosmic progression [P09].

2 Chaisson: the energy rate density comparison

The March heading called this the scale ladder, measured rather than inferred (V3-L05). Chaisson proposes energy rate density as a cross-domain complexity metric. For a stated energy throughput rate P and included mass M:

$$\Phi_m = P / M$$

Its SI units are watts per kilogram. Much of this literature uses cgs units, and the conversion is:

$$1 \text{ erg s}^{-1} \text{ g}^{-1} = 10^{-4} \text{ W kg}^{-1}$$

The values below are rounded examples from Chaisson's 2014 and 2015 accounts, not a new dataset or present-day estimates [P01, P02]:

Specified example	Approximate Φ_m	Accounting boundary
Sun	2×10^{-4} W/kg	Luminosity divided by total solar mass
Adult human body	2 W/kg	Food-energy consumption divided by body mass

Specified example	Approximate Φ_m	Accounting boundary
Adult human brain	15 W/kg	About 20 W divided by about 1.35 kg
Human society in the cited account	50 W/kg	Aggregate energy use divided by human body mass, excluding infrastructure

The March values of 10^2 W/kg for brains and 10^5 W/kg for civilization are not retained. More important than a repaired exponent is the boundary: the society estimate counts energy used through machines while excluding their mass. Comparing it with a brain or a star needs an argument for comparability, not just matching units.

What Chaisson provides: a quantitative comparison and a proposed interpretation of it. Energy rate density is not entropy production; watts per kilogram and joules per kelvin per second are different dimensions, and Chaisson's own program distinguishes the two [P02]. This chapter does not turn the proposed metric into a definition and then cite the resulting ranking as proof that complexity must rise.

What Chaisson does not provide: a distinction of quality. Φ_m counts watts per kilogram but does not ask what the energy is doing. That March observation stands.

What the framework adds: a question, not yet a measurement. The March chapter said the framework measures what energy is doing when it flows through a system that cares about another (V3-L06). A higher Φ_m does not establish greater care, meaning or relational benefit, and the Trinket and the transducer describe what the framework wants to investigate. They are not yet instruments.

3 England: not yet an origin story

The March heading called England's work the origin story: matter driven by external energy restructures to dissipate better, and self-replicators are favored because they are better dissipators (V3-L07). Three results need to be kept apart.

England's 2013 self-replication paper derives a lower bound on heat released to a thermal bath, with terms for internal entropy and for forward versus reverse transition probabilities. Its application to replication connects the bound to growth and decay rates. It does not show that replication necessarily begins, or that replicators dissipate more than every nonreplicator [P03].

Perunov, Marsland and England's 2016 adaptation paper analyzes relative outcome probabilities in specified driven stochastic dynamics. Dissipative history enters alongside other terms, including internal-entropy differences, reverse accessibility and fluctuations. Its analytical examples motivate a broader hypothesis about driven organization; they do not establish a universal rule that the most complex or most dissipative state wins [P04].

Chvykov and colleagues supply a different kind of result: robotic active-matter experiments, alongside simulations. Their rattling measure describes disorder in a configuration's driven response, estimated from short-time configuration displacements, and lower rattling predicts higher steady-state probability in the settings studied. It is not the variance of entropy production, and the theory has assumptions and identified limits [P07].

What these results provide: constraints on driven organization, a conditional account of how formation history enters outcome probabilities, and a tested experimental case.

What they do not provide: the thermodynamic reason relational systems arise. Neither a lower bound on replication heat nor a conditional account of driven self-organization derives connection, grief or the Trinket. Replacing “everything maximizes dissipation” with “everything stabilizes dissipation” would keep the overreach under a new verb.

What the framework adds: a question about how communication contributes to the maintenance or behavior of an already specified system. The March line that England explains why relational systems arise while the framework explains what they do is withdrawn (V3-L08). Those applications need their own dynamics and evidence.

4 Kolchinsky and Wolpert: information that matters

Kolchinsky and Wolpert define semantic information through counterfactual interventions on system–environment correlations and their effects on a chosen viability measure at a chosen time. Their principal viability choice is negative system entropy:

$$V(p_{X\tau}) = -H(p_{X\tau})$$

Here H is Shannon entropy, in bits, where the March text wrote S. A coarse-grained model also needs the internal entropies of its macrostates. Stored semantic information is the minimum retained mutual information, within the specified family of interventions, that preserves the actual viability value [P05].

For positive initial mutual information I_0, their stored thermodynamic multiplier is:

$$\kappa_{stored} = \Delta V_{tot} / I_0$$

With the negative-entropy choice, numerator and denominator are both in bits. The multiplier compares a viability effect with an idealized information-acquisition benchmark under stated energetic assumptions. It need not exceed one, it can be negative, and it is not a general conversion from meaning into joules (V3-L09).

What Kolchinsky and Wolpert provide: a formal way to separate information that matters to a specified system from information that does not.

What they do not provide: relational specificity, and the March chapter was right about that much. But the bridge it built across the gap is withdrawn (V3-L10). DFQ-001 records an internal argument; it does not establish that a proposed relational viability inherits a physical interpretation or has passed a test. The Shadow Economy is not their scrambling intervention, since a harmful interaction can be highly structured and informative. Nor does unreciprocated transmission add a third regime their framework lacks: it already allows partial interventions and asymmetric semantic effects [P05].

What the framework adds: a relational score would have to say whose outcome it represents, over what interval, under which interventions, and with what evidence that it measures the intended construct. Low uncertainty alone does not establish a healthy relationship.

5 Still: the thermodynamics of prediction

The March chapter credited this work to Bialek and colleagues, extended by Susanne Still. The cited 2012 paper is by Still, Sivak, Bell and Crooks (V3-L11). It analyzes a system responding to a stochastic external signal without feedback to that signal, starting in equilibrium, with Markovian response dynamics in an isothermal bath, with fixed-signal relaxation toward equilibrium. For one driving step they obtain, in nats:

$$\beta\langle W_{\mathrm{diss}}\rangle_{\mathrm{step}} = I(s_t; x_t) - I(s_t; x_{t+1})$$

where $\beta = 1/(k_B T)$. For the full protocol, summed nonpredictive information gives a lower bound on total mean dissipation, rather than the same equality for every component of the process [P06].

What Still and colleagues provide: a conditional relation between prediction and dissipation in a specified setting.

What it does not provide: proof that a person's transducer runs at minimum cost. A reciprocal conversation does not meet the no-feedback assumption merely because each participant predicts the other; a different model would be needed.

The March instruction to pay a Landauer tax on everything discarded is withdrawn. A cognitive label such as selection or compression does not identify a physical memory reset. For ideal reset of an unbiased bit in a symmetric isothermal memory, with no correlated side information used, the familiar heat benchmark is $k_B T \ln 2$. That is a result about a specified physical operation, not every ignored signal, and heat delivered to a bath and total entropy production remain distinct.

What the framework adds: a possible predictive target. What will this person do, what might this signal mean, which response would serve a defined relational aim? Filter geometry can organize that proposal. It does not show that the representation is optimal, that discarded material lacks value, or that its cost has been measured.

6 The synthesis

The March synthesis ran in four short lines: Chaisson provides the scale ladder, England the origin story, Kolchinsky and Wolpert the bridge, Still the formalism, and the framework the relational content none of them address.

The corrected lines run like this. Chaisson provides a proposed energy comparison. England and colleagues provide constraints on transitions, and Chvykov and colleagues a tested case of driven organization. Kolchinsky and Wolpert provide a counterfactual information measure. Still and colleagues provide a conditional prediction–dissipation relation. The framework provides a relational question none of them addresses, and not yet an answer.

The four can coexist in one research program. That does not make their strongest interpretations mutually confirming. Nor can the maximum entropy production principle supply the missing universal link. Martyushev's 2021 review advocates a formulation with locality and nonadditivity restrictions; it does not

give a demonstrated rule that all systems called complex maximize entropy production, and classifying a relationship or organism as complex does not establish applicability [P08].

The next chapter follows a selected history of physical, biological and technological developments. It must not present that history as a measured rise in one quantity, or as a trajectory these programs jointly predict. The Permission/Necessity Gap stays open at every transition.

What this chapter now claims

The relational question survives in a form that can fail a test. Specify the system, its environment, the information available, the intervention, the outcome and the horizon. Measure physical resources separately. Ask whether the proposed relational description explains or predicts something beyond an appropriate alternative.

No such validation is supplied by this survey. That is where the work begins.

Chapter 3: The Progression

From Atoms to AI, Tier by Tier

Status: Established observations and physical constraints are distinguished below from model-dependent results, analogies and interpretation. The Progression is a selected retrospective sequence, not an established law of increasing entropy production.

SupoRel boundary: Permission is not necessity, and an observed cost is not a demonstrated preference. Each transition needs its own mechanism and evidence. A nonteleological account does not, by itself, validate the Progression.

1 The arc

Atoms, stars, chemistry, life, brains, AI. This chapter walks the sequence step by step, with the tier of each claim marked. The March chapter opened by saying the observable universe traces a sequence of increasing entropy production per unit mass per unit time. That opening is withdrawn (V3-L13).

The first distinction is dimensional. Chaisson's energy rate density, Φ_m, is power divided by mass, in W/kg. An entropy-production rate per unit mass has units of W/(K·kg). Inferring entropy production from power requires a physical model of the system, its exchanges and its surroundings. A list of power densities is not a measured entropy-production ladder, and a sample of increasingly energetic systems is not evidence that every later system exceeds every earlier one [P01, P02; Q14].

The second distinction is about direction. Carroll's framing is useful here: physical explanations need prior conditions and dynamics, not an intended destination. Removing purpose does not establish a universal trend, or show that life and AI occupy inevitable attractor basins. The arrow of time and the direction of this chapter's narrative are different questions [Q01].

2 Atoms and initial conditions

Hydrogen radiating in the void. After recombination, the universe held largely neutral hydrogen and helium, distributed nearly uniformly on large scales with small perturbations. Smoothness matters when gravity matters: a smooth early universe can have low entropy relative to gravitationally collapsed alternatives, even when its matter and radiation are close to local thermal equilibrium [Q01].

The March section added: “The entropy budget has been set. The spending has begun.” It also assigned hydrogen a minimum entropy-production rate (V3-L14). The low-entropy past helps frame the thermodynamic arrow of time. It does not hand each later organism a fixed allocation of entropy tokens, and a finite ledger of order is a metaphor, not a cosmological quantity established here. Gravity, expansion, boundaries and coarse-graining all matter to any proposed accounting.

Tier: the broad cosmological setting is part of the standard physical account. The origin of the low-entropy past and a complete gravitational entropy accounting are not settled by invoking the second law. No progression toward intelligence follows from these statements.

3 Stars

The March chapter called fusion a controlled entropy acceleration engine running for billions of years. As an image it is vivid; as physics it is interpretive shorthand, not an additional result (V3-L15).

The physics is this. Gravity gathers and heats material during star formation. Sustained main-sequence luminosity is then powered chiefly by nuclear fusion, not by continued conversion of gravitational potential energy alone. The Sun fuses hydrogen into helium, and Borexino's observations of proton–proton neutrinos give direct evidence of that energy source [Q02].

Stars also make much of the chemical inventory later systems draw on. Carbon-12 is produced in helium burning through the triple-alpha process, not as a byproduct of the proton–proton chain. Different nuclei have different production histories, so “everything above helium is stellar waste” is too sweeping [Q03, Q15].

Mass-specific luminosity varies across stars and their evolutionary stages. It is an energy-flow measure, not a direct measure of complexity or entropy production. Stellar formation and nucleosynthesis explain particular physical transitions; they do not show that the universe was trying to reach the next rung [P01, P02].

Tier: Established for the identified fusion and nucleosynthesis processes.

4 Chemistry

The chemistry is real, and it is more interesting named precisely. Kvenvolden, Lawless and Ponnamperuma identified eight nonprotein amino acids in the Murchison meteorite and reported tentative evidence for four more. Hollis, Lovas and Jewell detected rotational emission attributed to glycolaldehyde toward Sagittarius B2(N). These are specific observations of organic compounds beyond terrestrial biology [Q04, Q05].

The March chapter drew a larger conclusion: each new molecular species is a new channel for entropy flow, and the building blocks of life are ordinary chemistry under ordinary conditions (V3-L16). The detections do not measure the probability that life begins, show that every ingredient is widespread in useful concentrations, or demonstrate an uninterrupted route from a cloud to a cell. A new molecular species may enable new reactions under suitable conditions; it does not automatically add a gradient or increase entropy production. Reaction rates, concentrations, catalysts and energy sources still have to be specified.

Tier: Established for the cited detections, within the methods and qualifications of those studies. Their place in a single cosmic ladder remains an interpretation.

5 Life

Living organisms maintain and reproduce organized structures through exchanges of energy and matter with their environments, and metabolism has physical costs. The March chapter went further: a single bacterium processes more entropy per unit mass per unit time than any nonliving chemistry. No

comparable entropy balances are supplied here to support that universal comparison, so it is withdrawn rather than softened (V3-L17).

The question remains: under which conditions can chemistry become a self-maintaining, reproducing system? Thermodynamic compatibility is one part of that question, not its complete answer.

The March chapter called “favored” the most important word in this chapter. It still is, because it needs a model. England's self-replication analysis derives a lower bound on heat dissipation for a specified replication process under stated assumptions. It does not establish that self-replication generally outcompetes every nonreplicating alternative. Work on driven adaptation relates outcomes to more than mean dissipation: kinetics, accessibility, fluctuations and the driving protocol all matter. Replacing “inevitable” with “favored” is not enough [P03, P04].

Tier: Supported within particular theoretical models or experimental systems, not as a universal explanation of life's origin (V3-L18). Conditional theoretical results and separate robotic experiments keep their own scope [P03, P04, P07]. Maximum entropy production remains a proposed principle whose use depends on its assumptions and constraints; Martyushev's review argues for restrictions on where it applies, and this chapter does not use it to certify the ladder [P08].

The Observation Split from Volume 1 offers a limited analogy: expenditure alone does not tell us what an interaction accomplishes, and thermodynamics likewise does not assign relational value to a physical cost. The March text put it starkly: the universe spends order constantly, and most of it builds nothing. No cosmic fraction is quantified here, and the analogy does not demonstrate a preference for meaningful configurations (V3-L19).

6 Multicellular life and brains

Differentiated tissues and nervous systems change what organisms can do and how energy is allocated. In adult humans at rest, the brain is roughly two percent of body mass and accounts for around one fifth of resting energy expenditure. The March chapter called brains the most expensive spenders per unit mass. In the adult resting-energy model evaluated by Wang and colleagues, heart and kidney rates per unit organ mass exceed the brain's [Q06] (V3-L20).

These facts establish substantial neural energy costs. They do not show that every transition to multicellularity, every added tissue or every increase in cognitive capacity raises mass-specific entropy production.

The March chapter raised the right objection to its own story: asking whether each layer emerged because the previous layer was not spending fast enough commits the Specificity Gap. An available gradient does not determine a particular organism, nervous system or evolutionary path. Its example needs one correction. The March text said fire and bacteria are equally valid dissipative responses to the same gradient. Combustion and metabolism have different mechanisms and constraints; calling both dissipative does not establish that they are equally accessible responses to a given gradient (V3-L21).

Looking backward makes the surviving path easy to narrate. Testing a general pattern would also require the less complex outcomes, the extinct lineages and the systems that never developed life. Their omission cannot count as evidence that thermodynamics disfavored them.

Tier: Supported for the scoped physiological findings. Neither a universal increase in entropy production nor the claim that a new layer appeared because the previous one was spending too slowly is established.

7 AI

The IEA's 2025 report estimates that data centres worldwide used about 415 TWh of electricity in 2024. That is the annual electricity use of data centres as a whole, including non-AI computing and supporting infrastructure. It is not an AI-only total, a power-per-mass measurement or an entropy-production estimate [Q07].

The March section also gave AI servers 53–76 TWh. The second edition's source check did not recover that range's primary provenance, and it is removed rather than relabeled (V3-L22) [Q12].

Digital computation plainly has material and energy requirements. Comparing an AI system with a brain would still need a specified task, system boundary, time interval and accounting method. The March chapter said that if the Progression holds, AI is not a technological accident but the next layer of the entropy acceleration architecture. AI arose through human engineering, institutions, investment and a particular technological history. Thermodynamics constrains the hardware; it does not identify AI as the destination of that history.

Calling AI another chapter in the Progression is a speculative interpretation, not an observation that a universal entropy-production pattern has continued. The question worth carrying forward is what these systems enable, at what physical cost, and under whose choices.

8 The frame rate question

The particles in the transducer diagram are discrete. The March chapter suggested this might be structural. It is a choice in the representation, and it does not show that consciousness, relational attention or physical entropy arrives in matching packets.

Some experiments connect perceptual performance to neural rhythms. Busch, Dubois and VanRullen found that the phase of ongoing EEG activity was associated with detection of near-threshold visual flashes, particularly in theta and alpha bands [Q08]. That is evidence about a particular perceptual task. The March claim of a universal human frame rate of 10–40 Hz, with the brain filling the gaps, is withdrawn; Varela and colleagues' 1981 paper is not used as proof of it, and VanRullen and Koch's 2003 article is a review [Q13] (V3-L23).

Questions about how distributed neural activity supports integrated perception remain meaningful. The binding problem cannot be reduced here to a proven film-splicing mechanism.

The March text described AI as frames separated by genuine discontinuity: context loaded, processing, context unloaded, and between sessions “not sleep, not unconsciousness. Absence.” A token, a context

window, an inference run and a chat session are different units, and a context limit does not by itself specify when a model is loaded, how application state persists or what runs between requests. No deployment was inspected for this volume, and neither the presence nor the absence of experience is asserted.

Even if a process has identifiable temporal intervals, energy use could be integrated over them without becoming a universal quantum of entropy. An entropy balance would still need the physical exchanges and temperatures, or an appropriate nonequilibrium model [Q14]. The March proposal that the Trinket is the relational content of a single frame, a minimum quantum of relationally directed entropy, is withdrawn (V3-L24). The Trinket can remain a conceptual unit for discussing a bounded act of relational attention. Turning it into a measurement would need an operational definition and evidence that distinguish it from an arbitrary accounting convention.

Tier: Supported for the cited task-specific neural finding; Analogical for the comparison with digital sequencing. The Behind the Substrate Barrier principle limits what this framework infers about experience. It cannot certify a common frame structure first and defer only the question of what those frames feel like (V3-L25).

9 The seven gaps applied

The framework's own logical firewall applies to its own claims with full force. The gaps are questions each claim must answer, not certificates that it has (V3-L28).

- **Gap 1, Permission/Necessity.** Compatibility with thermodynamics does not establish necessity or comparative likelihood. “Favored” needs a specified model and alternatives [P03, P04].
- **Gap 2, Specificity.** A gradient alone does not specify which structures form. Mechanisms, kinetics, boundary conditions and history matter.
- **Gap 3, Scale Mismatch.** A cosmological entropy discussion, an organism's metabolism and a data centre's electricity use do not share a measurement merely because all obey physical laws. Boundaries, units, exchanges and timescales must be made comparable [Q01, Q06, Q07; Q14].
- **Gap 4, Ergodicity and Sampling.** In the 2008 long-term evolution experiment report, one of twelve initially identical *E. coli* populations had evolved aerobic citrate use by 31,500 generations, and replay experiments supported a role for that population's prior history. This shows contingency in that experimental setting. The March gap said driven systems are non-ergodic; ergodicity is a property of a specified dynamical model and measure, not a synonym for divergent histories [Q09] (V3-L26).
- **Gap 5, Emergence.** Knowing microscopic laws does not automatically supply an explanation at another scale. Anderson's “More Is Different” argues for collective behavior and level-specific concepts; the March gap read it as showing higher-level properties are not derivable, and it is not a general theorem of that [Q10] (V3-L27).
- **Gap 6, Contingency.** Prior changes can alter what becomes accessible later. Historical constraint is not a forecast of which organism, technology or relational practice must arise [Q09].

- **Gap 7, Is–Ought.** Even a demonstrated energetic or thermodynamic tendency would not tell us what to value or what to build. The Progression is an interpretive way of arranging selected events. It supplies no mandate.

Chapter 4: The View from Outside

The Virus and the Star

Status: A literary thought experiment and its critique. The imagined stellar viewpoint is an analogy **[Analogical]**, not a physical hypothesis established by thermodynamics, and its physical limits are stated where it is used. Internal narrative consistency is not evidence of physical plausibility.

SupoRel flag: highest risk. The fever, host and correction language below must travel with its limits. None of it describes a stellar immune mechanism, a prediction about extraterrestrial civilizations or a prescription for human action.

1 The perspective shift

From inside the system, we call this progress: complexity, connection, culture, meaning, love.

The March chapter then stepped outside, to the perspective of a slow old star with billions of years of order left to spend, and found that from there we look like a disease. In its voice: “The star is spending its entropy budget over ten billion years. Life takes that output and builds machines that spend it in centuries. AI takes that output and may spend it in decades. Each layer is a faster burn. From the star's ledger: we are not its children. We are its fever.”

The passage still does what it was written to do. It unsettles our confidence that the universe shares our priorities. It cannot supply the universe with a perspective. The star here is a literary speaker, not an observer diagnosing a disease (V3-L29).

There is a physical limit the image cannot cross. Ordinary terrestrial use of already-emitted sunlight does not accelerate solar core fuel use; it changes what happens to some energy the Sun has already released. Burning stored terrestrial fuels draws on different reservoirs. These are not withdrawals from a single stellar account [Q02, Q11].

So “we are its fever” survives as a provocation about our own rates of consumption. It does not survive as an energy-flow calculation showing that industry or AI shortens the Sun's life; that causal link has not been supplied.

The virus comparison has its own limit. The March text defined a virus as an entity that accelerates its host's entropy production, and imagined the star's “immune response” as correction, “not malice.” Accelerating a host's entropy production is not a biological definition of a virus, and calling a response immune imports the machinery of a living system without identifying a stellar counterpart. Carroll's nonteleological guard belongs here, but removing intention does not repair a missing mechanism. An impersonal correction would still need a feedback pathway, equations and evidence, and the image supplies none of them.

2 The Fermi paradox reading

The March chapter took the image one step further: civilizations that build AI spend entropy fast enough to trigger systemic correction, and the system selected for maximum entropy production is the one most likely to trigger its own catastrophic phase transition. It called this one speculative reading among others, and it was right that the reading's emotional pull is the danger.

That reading is withdrawn as a scientific hypothesis (V3-L30). This chapter supplies no model, threshold or evidence connecting AI electricity demand to a stellar response, and thermodynamic laws do not, on their own, predict that AI-building societies trigger systemic correction. Calling a proposal speculative does not promote it to a hypothesis.

A narrower question survives, and it is worth asking: can a particular civilization's resource use undermine the conditions on which it depends? Answering it takes a specified environment, resource flows, mechanisms and evidence. It does not take a cosmic immune system. The framework must let an explanation fail when those links are missing; otherwise every ending becomes confirmation.

The capture vector is the existential cosmic narrative. Its emotional force is a reason for stricter testing, not a substitute for it.

3 Critical mass and release

Open systems can sustain nonequilibrium structures through exchanges with their surroundings. Some become unstable as forcing or constraints change, and their possible responses include new steady states, oscillations and other dynamical behavior. Prigogine's treatment requires attention to the particular system and its stability. It does not give a universal rule that accumulated tension must end in catastrophic release [Q14].

The March chapter called war a civilizational phase transition at maximum entropy production, and read a family argument, a divorce and a war as one operation at three scales (V3-L31). The three can be narrated as tension followed by rupture. That resemblance is literary and, at most, a starting point for a carefully specified model. This chapter has not defined a thermodynamic entropy for relationships, measured an entropy-production rate for conflict, or established a common order parameter across these events. It cannot rank them as small, larger and maximal instances of one physical operation.

Human suffering does not acquire an explanation, a necessity or a justification by being renamed dissipation. The causes and choices at each scale still need to be examined.

The March chapter held three things at once: the structural logic is real, the extrapolation is internally consistent, and the physics does not say this is how it works. The third clause carries the weight. The repetition of a shape in our descriptions is not proof of physical scale invariance; that claim would need defined variables and a demonstrated relation under changes of scale. Common physical constraints do not guarantee common mechanisms, causes, timescales or meanings.

The view from outside earns its place by showing how readily a pattern becomes a story about destiny or correction. The fever image changes the angle of attention. It does not change what the physics has established. Keep the question, identify the mechanism, and let the story stop where the evidence stops.

Analogy table: The star as host

The star-as-host image is Analogical, and it is the volume's highest-risk image. Its physical column states what the sources reviewed establish about the Sun and terrestrial energy use; its other column states the image. Nothing in the physical column supports the image's causal claims.

The image comes from March Chapter 4: “From the star's ledger: we are not its children. We are its fever.”

Term	Physical or biological reading (within stated scope)	Star-as-host reading	Where the mapping holds	Where it breaks
“host”	The Sun, a main-sequence star whose luminosity is powered chiefly by core nuclear fusion [Q02].	A body on which life lives and from which it draws.	Earth's living systems depend heavily on sunlight.	The Sun is not a living body with interests, a perspective or a ledger. “Host” imports biology without a stellar counterpart (Ch 4 §1).
“fever”	Terrestrial energy use, including stored fuels burned and electricity used for computation [Q07, Q11].	An accelerating burn that harms the host.	Rates of terrestrial energy use are real and measurable, and whether a given rate undermines the conditions a society depends on is a question that can be specified.	Ordinary terrestrial use of already-emitted sunlight does not accelerate solar core fuel use, and stored fuels are terrestrial reservoirs, not a stellar account [Q02, Q11]. The line survives only as a provocation about our own rates.
“virus”	Viruses replicate using host-cell components [D1].	An entity that accelerates its host's entropy production.	The image expresses unease about consumption outpacing the system that supplies it.	Accelerating a host's entropy production is not the biological definition of a virus, and the image identifies no replication or infection process (Ch 4 §1).
“immune response”	In biology, host defenses that detect and act against pathogens [D2].	The star correcting a runaway accelerator, “not malice.”	Feedbacks exist in many physical systems, so asking whether one applies is a legitimate question.	No stellar feedback pathway, equations or evidence is supplied by the sources reviewed. Removing intention does not supply a mechanism (Ch 4 §1–2).
“the star's ledger”	The Sun's output comes from nuclear fuel consumed in its core [Q02].	A metered budget of order that faster burners on Earth draw down.	The Sun's output does come from a finite fuel supply.	Terrestrial use draws on already-emitted sunlight or stored terrestrial energy; it does not thereby accelerate consumption of the Sun's nuclear fuel (see “fever”). A finite ledger of order remains a metaphor, not a cosmological quantity (Ch 3 §2; V3-L14).

What the table does not do

It is not evidence for the framework, not a prediction about extraterrestrial civilizations and not a prescription for human action. The physical column keeps its own standing within its stated scope; the star-as-host reading is Analogical in every row.

Promotion route (conditions, not a work plan)

An empirical extension must specify which claim and mapping it tests. For the stellar-correction proposal, that would require a defined pathway from terrestrial activity to stellar behavior, relevant dynamics, any claimed threshold, and evidence that could count against the claim. Support for a bounded mechanism would not establish literal stellar infection or immunity. None is supplied, and none is proposed here. The narrower resource-dependence question in §2 needs no stellar mechanism and stands on its own. No row is promoted.

Chapter 5: Process with Attractors

Pushed from Behind, Not Pulled Toward

Status: Causal framing informed by Carroll, with specified nonequilibrium results and a deliberately limited attractor vocabulary. The chapter does not establish a Carroll–England theory of cosmic complexity. The cosmological and relational extensions remain interpretive or **[Speculative]**. SupoRel applies to the corrective story as well as the original one.

1 The antidote must change the claim

The preceding chapters follow a selected path from physical structures to living systems and human technologies. It is an arresting sequence. The narrative looks like a story with a direction, and the March chapter promised to explain why it is not.

This edition makes a smaller promise: to show how a process can be explained without putting its outcome into its causes. A caution at the end would not repair a causal claim the evidence never supported. So this chapter withdraws the claim that the sequence is generated by a universal preference for increasingly complex dissipators, and the claim that calling the sequence nonteleological establishes that it has no purpose in every philosophical sense. The physics discussed here does not settle that question (V3-L35).

The useful distinction is narrower. The Permission/Necessity Gap asks what the dynamics allow, what they favor under specified conditions, and what they actually require. Those are three different claims.

2 Carroll and explanation from prior conditions

Carroll proposed aphormeology for explanation that originates in a past condition. In the March chapter's words, the appearance of teleology arises from two ingredients: a low-entropy initial state and the laws of physics operating on that state. That much stands. Carroll's account connects the thermodynamic arrow with a low-entropy past rather than a future goal, and “pushed from behind” is good shorthand for the contrast. It does not mean that temporal asymmetry is unreal, and it does not identify attractors for life or intelligence [P09].

For this volume the guard is methodological. Give the initial or boundary conditions, the dynamics and the physical resources relevant to the particular system, then ask what follows. A low-entropy past is not by itself a complete mechanism for a star, a replicator, a nervous system or a conversation. Each proposed transition needs its own explanation.

The March chapter continued: “The destination is not complexity. The destination is heat death,” with complexity as a waystation and the second law producing attractor basins for complexity along the way (V3-L32). A nonnegative entropy-production condition does not specify which available process occurs fastest, which structure appears or which outcome is most complex. A bound is not a trajectory. Nor does this argument need, or establish, an unconditional prediction of cosmic heat death.

Carroll's framing also leaves room for ordinary human purposes. A scientist can design an experiment and a person can intend to comfort someone without treating that intention as a goal built into cosmological laws. Physical explanation and the description of a person's purposes work at different explanatory levels, and this chapter need not erase either to avoid a cosmic mandate.

3 What the driven-systems results add

The March chapter's England complement gave three answers: complex structures arise because they dissipate better, persist because efficient dissipators are more stable, and replicate because replicators are the most efficient dissipators of all. None of those universal answers is established by the cited work (V3-L33).

Its chain ran: efficient dissipators happen to be complex, complex dissipators happen to include self-replicators, and so on down to brains and relational processing. The March text's best line came next: every “happen to” in that chain is a contingent step. That point survives; the chain's first links do not.

England's 2013 result constrains the heat associated with specified replication processes. The 2016 adaptation analysis relates outcome probabilities to formation histories in defined driven dynamics. A lower bound on expenditure is not a guarantee of origin, and a contribution to an outcome probability is not its only determinant [P03, P04].

The distinction is clearest in the low-rattling research. Chvykov and colleagues estimate C(q), the covariance of short-time configuration displacements, each divided by the square root of elapsed time, and use

$$R(q) = \tfrac{1}{2} \ln \det C(q)$$

as a Gaussian-entropy estimate up to an additive constant. With a fixed coordinate convention, their predictive relation is

$$p_{ss}(q) \propto \exp[-\gamma\, R(q)]$$

where γ is system-specific. Their robot experiments and simulations support this relation in the settings studied; it is not a universal nonequilibrium distribution [P07].

Low rattling concerns disorder in driven motion, not minimum variance of entropy production. It does not show that the universe maximizes, minimizes or stabilizes dissipation through complexity. The robot collectives give a bounded example of organization under a particular drive, not a measured thermodynamic destiny for organisms or civilizations.

That changes the synthesis. We may investigate whether a proposed system has a reproducible response to driving, and whether a specified information exchange helps maintain a chosen outcome. We cannot skip those measurements by declaring the system a favored dissipator. “Permitted and realized” still does not entail “required and inevitable.”

4 What counts as an attractor here

This chapter uses “attractor” technically only when a dynamical model makes the claim explicit: a state space, an evolution rule, and a set approached from an associated range of initial conditions. In noisy systems, long-lived configurations and concentrations of stationary probability may be the relevant objects instead. The terminology must follow a model rather than stand in for one.

The March chapter listed its basins: amino acids form readily, self-replicating molecules emerge far from equilibrium, nervous systems evolve independently in several lineages, and “the physics has basins for them” (V3-L34). The low-rattling robot study gives a concrete setting in which persistent collective behaviors and transitions between them can be investigated [P07]. It does not establish that atoms, amino acids, self-replicators, brains and intelligence are successive basins in one cosmic landscape. The phrase concealed absent models and unmeasured transition probabilities.

A useful attractor claim would say what varies across repeated trials, what stays fixed, how approach or persistence is measured, and what observation would count against it. Repeated occurrence of a broadly similar output would motivate that investigation. It would not by itself demonstrate one shared mechanism across scales.

The Cosmological Entropy Session's formulation, “process with attractors, not entity with goals,” can remain a guide to questions. Its first half needs a model wherever it is used technically; its second half describes the explanatory stance of this volume, not a result proving the absence of every possible cosmic purpose. Calling it a finding in an internal session adds no empirical support.

The Principal's line, “we could be the 6 billionth attempt,” is kept only as speculative narration **[Speculative]**. This chapter supplies no evidence for earlier cycles, a count of attempts or repeated production of intelligence. Even within a proposed cyclic model, similar outcomes would need an argument about the relevant dynamics and boundary conditions; unchanged laws alone would not establish the probabilities.

Nor can the attractor vocabulary predict a broad class of outcomes merely by declining to predict a particular species. “Intelligence will recur” is still a prediction that needs evidence. The Ergodicity Gap and the Contingency Gap forbid treating accessible states as states guaranteed to be visited, or known outcomes as unavoidable consequences of the laws.

5 What this does to the Progression

The Progression can remain a comparison of selected developments and the conditions that made them possible. Its historical interest does not depend on a universal complexity law. A successful account would say which transitions are well explained, which remain open, and which relational connections are proposals rather than physical deductions.

The March chapter put the danger well: legible patterns generate narratives, narratives generate teleology, and teleology is what the framework cannot afford to produce. The corrected version adds one more step. A corrective narrative can generate its own teleology. Maximum dissipation sounds like a purpose, so stable dissipation is substituted and called a resting point. That change is rhetorical unless the system,

quantity and dynamics are specified, and a corrective metaphor can acquire the authority of a law as easily as the original did.

SupoRel therefore applies to the framework's own explanation. An account organized around entropy will direct attention toward entropy-related descriptions; that choice does not establish that they explain everything important about the cases. We should ask what alternatives were left out and what evidence could favor one explanation over another.

The relational application remains ambitious. It asks how physical systems come to sustain patterns that matter to one another, how those patterns are represented, and what happens when an intended connection is not registered or returned. Answering will take more than physical resource accounting, but it need not deny that accounting. Costs, information, outcomes and purposes can be investigated without giving them one name.

What this chapter now claims

Prior conditions and specified dynamics can support explanations that do not invoke a future cosmic goal. The cited driven-systems results show why particular questions about organization are tractable; they do not establish a universal path to complexity, life, intelligence or the Trinket. Attractors must be demonstrated in a model or marked as analogy. The Permission/Necessity Gap remains a constraint on the framework itself.

The antidote is not certainty that the universe has no purpose. It is refusing to present an untested interpretation as a consequence of physics.

Chapter 6: What the Pattern Reveals

The Progression and the Documents It Connects

Status: This chapter draws limited implications from the preceding review. It adds no empirical validation of the framework. References to other project documents identify dependencies; they do not certify or amend those documents.

1 What this volume did

The March chapter began with the volumes in a row: Volume 1 established the substrate, one economy; Volume 2 established what the body pays; Volume 3 asked why any of this exists. The corrected row reads differently. Volume 1 keeps three accounts apart. Volume 2 reads what the body records. Volume 3 still asks the oldest question in the series: how should we understand the physical context in which relational systems arise?

The March answer, at the Supported tier, was that dissipative structures are thermodynamically favored and relational systems are dissipative structures (V3-L36). This volume has not answered with a universal preference for complexity or connection. It has separated research programs the March account joined too quickly. Energy rate density describes a chosen power-to-mass ratio. Replication bounds constrain specified physical processes. Models and experiments on driven self-organization investigate particular dynamics and state distributions. Semantic-information and prediction formalisms define different quantities for different questions. Each can inform a carefully specified investigation. Their conjunction does not establish a thermodynamic origin story for every relational system.

The correction is deeper than replacing “necessary” with “favored.” “Favored” is still a substantive comparative claim. Without a defined comparison, dynamics and evidence, it is not the cautious version of an established result. It is an unsupported result with a softer adjective.

The revised Progression is a set of historical examples and proposed questions. Its value depends on whether those questions can be made informative, not on preserving a single cosmic ladder.

2 What follows for the scale invariance claim

The March chapter gave DB-01 its deepest available reason: the same thermodynamics at every scale, one entropy budget, one set of laws. “The fractal is not metaphorical. It is thermodynamic.” That support is withdrawn (V3-L37).

Shared physical constraints do not make a cell, a family and a civilization instances of one measured dynamical model. Similar language about accumulation, tension and release does not establish a common cause, critical threshold or scaling relation. A scientific scale-invariance claim needs defined observables and a specified transformation of scale; a proposed connection would then have to show what stays invariant, which parameters change and where the comparison fails. A fractal description likewise needs more than visual or rhetorical recurrence.

The social examples in Chapter 4 remain analogies unless that work is done. Treating arguments, divorces and wars as instances of one cross-scale entropy-release mechanism would hide the human choices and institutions an explanation needs to examine. Nothing in this volume makes those events physically inevitable or morally required.

DB-01 itself is not rewritten here. The dependency is flagged: any claim there that Volume 3 supplies a thermodynamic derivation of scale invariance needs separate reassessment.

3 What follows for MEPP and low rattling

The March chapter accepted the MEPP Assessment Note's "Supported" classification and called thermodynamic favor a weaker claim with stronger epistemic standing (V3-L38). The internal label is not a universal license. Any application of a maximum-entropy-production proposal must name the formulation, constraints, admissible alternatives and quantity being optimized. Results for one class of systems cannot be transferred to relational behavior by the word "complex."

The separate structural revision package correctly saw the need for stronger limits, but some of its proposed scientific guards were themselves inaccurate. Low rattling is not defined as low variance in entropy-production rate, and its observed selection in particular driven systems does not establish that the universe generally stabilizes dissipation. A review's proposed domain restrictions for MEPP are not an empirical division in which complex systems obey the principle and simple systems do not. The package's editorial purpose is kept: expose the unsupported inference where it occurs. Its inaccurate mechanisms are not adopted [P07, P08].

The March chapter's rule was: use the physics without worshipping the physics. The corrected rule is more specific: use the physics without making the name of a principle do the work of a model.

4 The revised five-volume relationship

The March volume set itself at the center of five: Volumes 1 and 2 describe how the system works, Volumes 4 and 5 its boundaries, and Volume 3 why the system exists at all, the landscape that produces relational systems as a class (V3-L39).

The revised volumes relate differently. Volume 1 separates energy, entropy, information, registration and relational evaluation; it establishes no single calibrated currency for every relationship. Volume 2 distinguishes physiological observations and reported difficulty from physical expenditure; it does not validate the Mz, a clinical mechanism of grief or a biomarker of sincerity. Volume 4 treats substrate and outcome comparisons as problems to specify, not a universal efficiency ranking. Volume 5 distinguishes cosmological entropy inventories, accessible resources, conditional horizon results and information-recovery tasks; it does not restore a universal relational budget.

Volume 3 must stay compatible with those distinctions. The physical cost of an implemented process does not settle its benefit, significance or experiential character. A history containing relational systems does not show that thermodynamics specifically selects relational value. The Observation Split can motivate a comparison between an intended act and its result; it is not a cosmological theorem about every entropy-producing process.

WP-19, DFQ-001, the MEPP Assessment Note and the Cosmological Entropy Session findings remain separate historical documents. Where their claims rely on the former universal progression, that reliance is an open dependency, not a result this collection rescues.

5 A research question rather than a destination

The March chapter judged the capture surface contained by structural means: tiers marked, Chapter 4 labeled Speculative throughout, the Carroll–England antidote supplied, the gaps applied (V3-L40). It also admitted the containment was not perfect. That admission was the truest line in the section. Containment is not tested by how many guards are in place but by whether the claims behind them stay within their evidence.

A productive next step would select one proposed bridge. It would define the system and its boundaries, the relevant observations, plausible alternatives and a result that would count against the proposal, keeping a resource measure, a prediction measure and a relational outcome distinguishable even when their relation is studied. This volume claims no novelty for such an approach and supplies no study protocol. It identifies the missing work. A failed bridge should be allowed to fail, not survive by retreating into metaphor whenever its measurements disagree.

The founding line about love and entropy remains part of the framework's history **[Analogical]**. As a motivating image, it asks what people invest and what their investment does. It does not supply a universal entropy inequality, require sacrifice or establish that care is more valuable when it costs more.

The March volume ended: if the reader walks away understanding that the universe produces relational systems because dissipation favors them, not because connection is sacred, the volume has done its work. That sentence made both halves into findings. This edition makes neither. The physics reviewed here does not show that dissipation favors relational systems, and it does not show that connection is or is not sacred.

The question that remains is ambitious enough: under specified conditions, what helps a system develop and sustain a connection, and how do physical constraints take part in that history? Answering it will take more than arranging the universe's history into a story that ends with us.

Volume 3 correction ledger

The ledger traces 40 selected March claims in Volume 3. By this edition's classification of the second edition's treatment, 15 were withdrawn, 23 narrowed and 2 kept. It is not an exhaustive inventory, and it makes no new scientific decisions.

March locations refer to the preserved Volume 3 page on suposystem.ai. Second-edition (2E) locations use the October 2026 Volume 3 headings and its local P and Q labels.

ID	March claim (Volume 3 location)	2E disposition	2E location	Basis
V3-L01	Front, Ch 1 §3: the most SupoRel-active volume; Carroll as antidote; philosophy of physics with physics guardrails, not a derivation.	Kept; SupoRel's test is whether claims stay within evidence	Ch 1 §3; Ch 5 §1	The framing survives; an antidote is not certainty that the universe has no purpose.
V3-L02	Ch 1 §1: each layer processes more entropy per unit mass per unit time; the watts per kilogram are measured.	Withdrawn	Ch 1 §1; Ch 3 §1 [P01, P02; Q14]	Φ_m is W/kg; entropy production per mass is W/(K·kg). The sequence is selected.
V3-L03	Ch 1 status, §2: dissipative structures are more probable in driven systems (Supported); complexity is a statistically favored configuration.	Narrowed: “favored” needs a specified model and alternatives	Ch 1 §2; Ch 3 §9 Gap 1 [P03, P04]	A probability comparison for one driven model does not carry across every scale.
V3-L04	Ch 1 §2–3: the teleological reading is identical to every major religious tradition's argument; the trajectory has no destination.	Narrowed	Ch 1 §3; Ch 5 §1	The physics reviewed does not settle purpose either way, and the volume need not classify every tradition.
V3-L05	Ch 2 §2: Chaisson's scale ladder (brains ~10^2, civilization ~10^5 W/kg) is measured, not inferred; Φ_m rises with complexity across cosmic history.	Narrowed: rounded 2014–2015 examples with boundaries; brain and civilization values not retained	Ch 2 §2 [P01, P02]	Brain about 15 W/kg; society about 50 W/kg, excluding machine mass. No monotonic rule.
V3-L06	Ch 2 §2: energy through a transducer is entropy filtered into relationally structured output; the framework measures what energy does when a system cares.	Withdrawn as a measurement; kept as a question	Ch 2 §2	The Trinket and transducer are not yet instruments; higher Φ_m does not mean more care.
V3-L07	Ch 2 §3: England shows matter restructures to dissipate better; replicators are better dissipators; this is why complexity arises.	Narrowed	Ch 2 §3; Ch 5 §3 [P03, P04]	A replication heat bound and a conditional driven-dynamics result, with other terms; no universal rule.
V3-L08	Ch 2 §3: England explains why relational systems arise; the framework explains what they do (exchange entropy tokens, filter, connect, grieve).	Withdrawn	Ch 2 §3	The cited work does not derive the emergence of relational systems.
V3-L09	Ch 2 §4: viability V(ρ) = −S(p_Xτ); κ shows semantic information is worth far more than its Landauer cost.	Narrowed and corrected	Ch 2 §4 [P05]	$V = -H$ in bits; $\kappa_{stored} = \Delta V_{tot} / I_0$ need not exceed one and can be negative. Not a conversion of meaning into joules.
V3-L10	Ch 2 §4: DFQ-001 established that V_{rel} extends Kolchinsky–Wolpert; Shadow is the scrambled condition; unreciprocated transmission is a third regime.	Withdrawn	Ch 2 §4 [P05]	As V1-L12, V1-L19 and V2-L23. An internal argument is not validation.
V3-L11	Ch 2 §5: Bialek's framework, extended by Still, shows the transducer processes predictive information at minimum cost; pay the Landauer tax on discards.	Narrowed; attribution corrected; tax instruction withdrawn	Ch 2 §5 [P06]	Still, Sivak, Bell and Crooks: a no-feedback, Markovian, isothermal setting. A transducer is not shown optimal.

ID	March claim (Volume 3 location)	2E disposition	2E location	Basis
V3-L12	Ch 2 §6: the four programs are simultaneous scaffolds; relational processing is part of the dissipative structure the physics favors.	Withdrawn	Ch 2 §6 [P08]	Distinct resources, not mutual confirmation. MEPP does not supply the link.
V3-L13	Ch 3 §1: the universe traces increasing entropy production per unit mass per unit time.	Withdrawn	Ch 3 §1 [P01, P02; Q14]	A list of power densities is not a measured entropy-production ladder.
V3-L14	Ch 3 §2: hydrogen at minimum entropy production; “the entropy budget has been set. The spending has begun” (Established).	Narrowed	Ch 3 §2 [Q01]	A smooth, low-entropy early universe is standard; a finite ledger of order is a metaphor.
V3-L15	Ch 3 §3: stars convert gravitational potential energy; the periodic table above helium is stellar waste (Established).	Narrowed	Ch 3 §3 [Q02, Q03, Q15]	Main-sequence light is powered chiefly by fusion; carbon comes from the triple-alpha process; nuclei have different histories.
V3-L16	Ch 3 §4: every molecular species is a new channel for entropy flow; life's building blocks are ordinary chemistry (Established).	Narrowed	Ch 3 §4 [Q04, Q05]	The Murchison amino acids and glycolaldehyde detections are kept; no probability of life follows.
V3-L17	Ch 3 §5: a single bacterium processes more entropy per unit mass than any nonliving chemistry.	Withdrawn	Ch 3 §5; Remaining questions	No comparable entropy balances are supplied here to support the universal comparison.
V3-L18	Ch 3 §5: England's mechanism is empirically demonstrated (Supported); MEPP is Supported.	Narrowed	Ch 3 §5 [P03, P04, P07, P08]	Conditional theoretical results and separate robotic experiments retain their own scope; neither establishes a universal origin mechanism, and MEPP does not certify the ladder.
V3-L19	Ch 3 §5: the Observation Split at cosmic scale: the universe spends order constantly, and most of it builds nothing.	Narrowed: a limited analogy	Ch 3 §5	No cosmic fraction is quantified here; the analogy does not demonstrate a preference for meaningful configurations.
V3-L20	Ch 3 §6: each layer processes more entropy per unit mass; brains are the most expensive spenders per unit mass.	Narrowed	Ch 3 §6 [Q06]	Adult human brain at rest: about 2% of mass and a fifth of resting expenditure. In the adult resting-energy model evaluated by Wang et al, heart and kidney rates per unit organ mass exceed the brain's.
V3-L21	Ch 3 §6: fire and bacteria are equally valid dissipative responses to the same gradient.	Narrowed	Ch 3 §6	Combustion and metabolism have different mechanisms and constraints; calling both dissipative does not establish that they are equally accessible responses to a given gradient.
V3-L22	Ch 3 §7: data centres used ~415 TWh in 2024, AI servers 53–76 TWh; AI is the next layer of entropy acceleration.	Narrowed: 415 TWh kept as all data centres; 53–76 TWh removed	Ch 3 §7 [Q07, Q12]	The second edition's source check did not recover the range's primary provenance; “next layer” is speculative interpretation.
V3-L23	Ch 3 §8: consciousness samples reality in discrete frames at 10–40 Hz, and the brain interpolates the gaps.	Withdrawn as universal; a task-specific finding kept	Ch 3 §8 [Q08, Q13]	EEG phase predicted detection of near-threshold flashes in one task.
V3-L24	Ch 3 §8: AI frames as context loads; each frame a discrete entropy draw; the Trinket as the relational content of one frame, a minimum quantum.	Withdrawn	Ch 3 §8 [Q14]	Tokens, context windows, runs and sessions are different units; no entropy quantum is established here. The Trinket stays a conceptual unit.
V3-L25	Ch 3 §8: the frame correspondence is observable; the BSB applies only at the experiential claim.	Narrowed: Supported for the neural task, Analogical for the digital comparison	Ch 3 §8	The BSB cannot certify a common frame structure first and defer only experience.

ID	March claim (Volume 3 location)	2E disposition	2E location	Basis
V3-L26	Ch 3 §9, Gap 4: driven systems are non-ergodic (the LTEE citrate result).	Narrowed	Ch 3 §9 [Q09]	LTEE shows contingency in that setting; ergodicity is a property of a specified model.
V3-L27	Ch 3 §9, Gap 5: higher-level properties are not derivable from lower-level laws (Anderson).	Narrowed	Ch 3 §9 [Q10]	Anderson argues for level-specific concepts, not a theorem of non-derivability.
V3-L28	Ch 3 §9: the seven gaps as the framework's logical firewall, applied to its own claims.	Kept as an internal checklist	Ch 3 §9; Ch 6 cross references	Using the gaps does not certify that a claim has met its burden of evidence.
V3-L29	Ch 4 §1: from the star's ledger we are its fever; a virus accelerates its host's entropy production; correction would be an immune response (Speculative).	Narrowed: a literary thought experiment with physical limits stated	Ch 4 §1 [Q02, Q11]	Ordinary terrestrial use of already-emitted sunlight does not accelerate solar core fuel use; no stellar immune mechanism is supplied by the sources reviewed.
V3-L30	Ch 4 §2: civilizations that build AI spend entropy fast enough to trigger systemic correction (Fermi reading).	Withdrawn as a hypothesis; a narrower resource question kept	Ch 4 §2	This chapter supplies no model, threshold or evidence connecting AI electricity demand to a stellar response.
V3-L31	Ch 4 §3: war is a civilizational phase transition at maximum entropy production; argument, divorce and war are one operation at different scales.	Withdrawn	Ch 4 §3 [Q14]	This chapter has not defined a thermodynamic entropy for relationships, measured an entropy-production rate for conflict, or established a common order parameter across these events.
V3-L32	Ch 5 §2: the destination is heat death; complexity is a waystation; the second law produces attractor basins for complexity.	Narrowed: Carroll's guard kept	Ch 5 §2 [P09]	A bound is not a trajectory; neither heat death nor basins for life are established here.
V3-L33	Ch 5 §3: complex structures arise, persist and replicate because they are efficient dissipators (Carroll–England synthesis, Supported).	Withdrawn	Ch 5 §3 [P03, P04, P07]	None of the three universal answers is established by the cited work.
V3-L34	Ch 5 §4: “the physics has basins” for amino acids, replicators, nervous systems and intelligence; Finding A5; the six-billionth attempt.	Narrowed	Ch 5 §4 [P07]	An attractor needs a specified model. A5 stays a guide to questions; the cyclic count is speculative narration.
V3-L35	Ch 5 §5 and What this chapter has established: the Progression is pushed from behind; the Permission/Necessity Gap is the antidote to every teleological reading.	Narrowed: the nonteleological stance kept	Ch 5, What this chapter now claims	The antidote refuses to present interpretation as physics; it is not certainty of no purpose.
V3-L36	Ch 6 §1: relational systems arise because dissipative structures are favored (Supported).	Withdrawn	Ch 6 §1	“Favored” without a defined comparison is an unsupported result with a softer adjective.
V3-L37	Ch 6 §2: the Progression gives DB-01 its deepest reason; “the fractal is not metaphorical. It is thermodynamic.”	Withdrawn; DB-01 dependency flagged	Ch 6 §2	Shared constraints do not make cell, family and civilization one measured model (as V1-L21).
V3-L38	Ch 6 §3: MEPP is Supported; thermodynamic favor is a weaker claim with stronger standing; the volume shows responsible MEPP use.	Narrowed	Ch 6 §3 [P08]	The label is not a universal license; “favored” is still a substantive claim.
V3-L39	Ch 1 §3, Ch 6 §4: Volume 1 establishes one economy; Volume 3 explains why relational systems exist as a class.	Withdrawn; five-volume relationship revised	Ch 6 §4	A history containing relational systems does not show that thermodynamics selects relational value.
V3-L40	Ch 6 §5: the capture surface is contained by structural means; the universe produces relational systems because dissipation favors them.	Narrowed	Ch 1 §3; Ch 6 §1, §5	Containment is tested by claims staying within evidence; the favor claim is withdrawn.

References and source apparatus

Inherited verbatim from the second edition's Volume 3 apparatus, with the calculation note's fractions and exponents restored from its original equation markup. Group P serves the physics programs; group Q serves the Progression's evidence and limits.

Physics reference group P

Verified on 28 October 2026. These references support the stated bounded claims, not a consensus around the Trinket Soul Framework. Publisher identifiers refer to the published works; accessible author copies are identified separately. The two Chaisson articles are the research program author's syntheses, not independent replications. Martyushev is a review advocating a position. Carroll is primary author exposition of his framing, not an empirical attractor study.

P01 Chaisson 2014

Chaisson, E. J. (2014). The Natural Science Underlying Big History. *The Scientific World Journal*, 2014, 384912. Published article.

Verified locations: definition and qualifications in §3; human brain in §4.6.2; society numerator and human-mass-only denominator in §4.7.1. Use for reporting the author's proposed metric and historical estimates, not an established universal complexity scale. Chapter 2 numeric comparison and Chapters 1/3 cross-summary may cite this with that attribution.

P02 Chaisson 2015

Chaisson, E. J. (2015). Energy Flows in Low-Entropy Complex Systems. *Entropy*, 17(12), 8007–8018. DOI. Author-hosted published PDF.

Verified locations: §§1, 3–5, especially §4 unit conversion and Sun/body/society examples. Use for the energy-versus-entropy distinction and the program's own scope. This is explicitly a review. The arXiv author manuscript was also checked but has placeholder journal pagination; cite the published PDF above.

P03 England 2013

England, J. L. (2013). Statistical physics of self-replication. *The Journal of Chemical Physics*, 139, 121923. DOI. Author-hosted published PDF.

Verified locations: macroscopic irreversibility, equations (8) and (10); qualifications surrounding equation (11); replication examples. Original theory with empirical-parameter applications, not an origin-of-life experiment. Supports a bound, not a universal ranking of dissipators. Appropriate for Chapters 1–3 and 5 where the distinction is explicit.

P04 Perunov Marsland and England 2016

Perunov, N., Marsland, R. A., and England, J. L. (2016). Statistical Physics of Adaptation. *Physical Review X*, 6, 021036. DOI. Author-hosted published PDF. MIT repository record.

Verified locations: introduction; generalized outcome relation, equations (10)–(11); discussion of cyclical dissipation; illustrative driven-landscape and replicator examples. Original theoretical analysis and models. Do not merge its finite-time formation-history result with England's 2013 bound or equate it with a maximum steady-state entropy-production law. Supports Chapters 1–3 and 5 cross-summary only at that scope.

P05 Kolchinsky and Wolpert 2018

Kolchinsky, A., and Wolpert, D. H. (2018). Semantic information, autonomous agency and non-equilibrium statistical physics. *Interface Focus*, 8, 20180041. DOI. Author-hosted published PDF. Author manuscript.

Verified locations: §4, equation (4.1); §5.1 interventions and stored information; §5.1.3, equation (5.12); §5.2; appendix B. In the arXiv version, the corresponding viability/multiplier equations are (2)/(15). Original formalism and toy models; no validation of Vrel, relational entropy currencies, or a new unreciprocated regime. Main-text definitions control over ambiguous OCR or appendix notation.

P06 Still and colleagues 2012

Still, S., Sivak, D. A., Bell, A. J., and Crooks, G. E. (2012). Thermodynamics of Prediction. *Physical Review Letters*, 109, 120604. DOI. Author manuscript v3. Publisher accepted-manuscript record.

Verified locations: problem setup; equations (13)–(21), particularly driving-step equality (14), whole-protocol inequality (18), and erasure account (19). Original theory. Retain no-feedback, equilibrium preparation, bath, response, and relaxation assumptions. Does not supply a per-stage cognitive erasure cost or establish that a human relational processor is optimal. Chapters 1/2 cross-summary may cite it only as a conditional result.

P07 Chvykov and colleagues 2021

Chvykov, P., Berrueta, T. A., Vardhan, A., Savoie, W., Samland, A., Murphey, T. D., Wiesenfeld, K., Goldman, D. I., and England, J. L. (2021). Low rattling: A predictive principle for self-organization in active collectives. *Science*, 371(6524), 90–95. DOI. Accepted manuscript and supplement. PDF.

Verified locations: main equations (1)–(3), assumptions preceding them, robot experiments, and supplementary counterexamples. Theory, simulations, and robotic active-matter experiments. Not an entropy-production-variance result or a universal stabilization law. Supports corrected Chapters 2/5 and the Chapter 6 summary.

P08 Martyushev 2021

Martyushev, L. M. (2021). Maximum entropy production principle: history and current status. *Physics–Uspekhi*, 64(6), 558–583. DOI. Journal-hosted English PDF.

Verified locations: §3 formulation and justification; §3.1 locality; §3.2 complexity/nonadditivity. Review and advocacy, not a newly established empirical domain map. The author distinguishes local constitutive claims from integral behavior. Its proposed restrictions do not certify applicability to every biological or relational system. Cite in Chapters 2/3/6 as the review's position, not consensus.

P09 Carroll 2014

Carroll, S. (2014, February 3). Reality, Pushed From Behind. Author's essay.

Verified locations: essay body before comments, especially the Past Hypothesis discussion and proposed term aphormeology. Primary author exposition of a causal/philosophical framing, not peer-reviewed empirical evidence of cosmic attractors. Use across the volume as framing. The Past Hypothesis is not attributed as Carroll's invention. The 2016 book was not used to supply an unverified page citation.

Progression references and evidence limits

Checked 28 October 2026. Q references support Chapters 3 and 4; P references appear in the preceding group. The original manuscript and the other volumes are not external scientific validation. No new experiments, clinical measurements, or deployment inspection were conducted.

Q01 Low entropy cosmological background

Sean M. Carroll and Jennifer Chen. **Spontaneous Inflation and the Origin of the Arrow of Time** (2004), arXiv:hep-th/0410270. Author paper; full text.

Type and locator: Original theoretical proposal, §1, printed pp. 3–4. Full text available; relevant introductory discussion inspected. It distinguishes ordinary matter/radiation entropy from entropy associated with gravitational collapse and emphasizes the low-entropy boundary-condition problem.

Use and limit: Supports the low-entropy-past/gravity distinction, not a finite universal token allowance. The paper's proposed spontaneous-inflation explanation is not imported or described as established. It supplies no empirical ladder from atoms to AI. The recombination description is standard cosmological background, not claimed as a new observation by these authors. The chapter makes no numerical primordial-entropy estimate and no settled gravitational entropy definition.

Q02 Solar nuclear energy

Borexino Collaboration. **Neutrinos from the primary proton–proton fusion process in the Sun.** *Nature* 512, 383–386 (2014). DOI 10.1038/nature13702.

Type and locator: Primary neutrino observation; publisher abstract and article metadata inspected. It reports spectral observations of solar pp neutrinos, supporting hydrogen-to-helium fusion as the Sun's principal energy source.

Use and limit: Establishes the nuclear-source distinction. The chapter does not reproduce the paper's percentage estimate as a current universal stellar value. It distinguishes gravitational contraction during formation from sustained main-sequence nuclear luminosity. The conclusion that ordinary terrestrial use of already-emitted sunlight does not increase core fuel use is a physical boundary/causality inference, not an experiment performed in the Borexino paper. No proposed stellar feedback mechanism is supplied by the manuscript.

Q03 Carbon production

Hans O. U. Fynbo et al., ISOLDE Collaboration. **Revised rates for the stellar triple-α process from measurement of 12C nuclear resonances.** *Nature* 433, 136–139 (2005). DOI 10.1038/nature03219.

Type and locator: Primary nuclear-resonance measurement and derived reaction-rate analysis; publisher-indexed abstract and metadata inspected. A subsequent direct publisher open encountered an inaccessible redirect.

Use and limit: Supports the identity of the triple-alpha helium-burning route to carbon-12. It is not used for a numerical present-day reaction rate, all stellar stages, or the complete origin of every element. The package's proton–proton-chain-to-carbon assertion is a factual error and is replaced, not qualified as speculative. Q15 supplies a separate reason not to collapse all origins above helium into ordinary stellar fusion waste.

Q04 Meteoritic amino acids

Keith A. Kvenvolden, James G. Lawless, and Cyril Ponnamperuma. **Nonprotein Amino Acids in the Murchison Meteorite.** *PNAS* 68(2), 486–490 (1971). DOI 10.1073/pnas.68.2.486; primary article at PMC.

Type and locator: Primary chemical analysis; abstract and article metadata inspected. Eight nonprotein amino acids were conclusively identified; four additional identifications were tentative.

Use and limit: The reader preserves this difference in confidence. Finding compounds in this meteorite is not direct observation of their formation on a meteorite, proof of their abundance everywhere, or a probability estimate for the origin of life. The full scanned methods/tables were not independently reanalyzed; no new abundance or contamination claim is made. The related 1970 Nature result was found but is not needed as a second evidentiary vote.

Q05 Interstellar organic detection

J. M. Hollis, F. J. Lovas, and P. R. Jewell. **Interstellar Glycolaldehyde: The First Sugar.** *Astrophysical Journal Letters* 540, L107–L110 (2000). DOI 10.1086/312881. Primary-paper mirror.

Type and locator: Primary radio-spectroscopic detection, abstract and §2 Observations and Results. Search-indexed paper text inspected; direct publisher access was robots-blocked and a direct mirror open failed. The available primary text identifies millimetre-wave rotational emission toward Sagittarius B2(N), with observations in May 2000.

Use and limit: The proposed wording is confined to the reported detection and target. It claims neither life nor a universal synthesis route, concentration, or environmental frequency. The paper's use of biomarker terminology is not imported as evidence of biology. No novel spectral reanalysis is claimed.

Q06 Adult organ energetics

ZiMian Wang et al. **Specific metabolic rates of major organs and tissues across adulthood: evaluation by mechanistic model of resting energy expenditure.** *American Journal of Clinical Nutrition* 92(6), 1369–1377 (2010). DOI 10.3945/ajcn.2010.29885; full primary article.

Type and locator: Original secondary analysis of a physiological dataset, n=131 healthy nonobese adults, ages 21–73. Abstract, measurement methods, Tables 2–3, and model description inspected. MRI organ masses and whole-body indirect calorimetry evaluate proposed organ-specific coefficients; these are not direct independent calorimetry measurements of each organ.

Use and limit: Elia's evaluated coefficients include brain 240 and heart/kidneys 440 kcal/(kg·day). Thus the brain is not the highest rate per organ mass in this model. Adult resting conditions matter. The approximate 2%/20% language is consistent with the cohort calculation below, not a universal fraction for children, exercise, every person, or entropy production.

Q07 Dated global data centre estimate

International Energy Agency. **Energy and AI** (2025), chapter **Energy demand from AI**, section **The outlook for energy demand from data centres**. Primary report chapter.

Type and locator: Primary institutional model-based estimate, not a census of individually metered AI workloads. Relevant online section and component definitions inspected. It estimates approximately 415 TWh of worldwide data-centre electricity consumption in calendar 2024; site infrastructure is part of the scope.

Use and limit: The chapter dates the report and estimate explicitly. It does not label 415 TWh as all AI, primary energy, entropy, or W/kg. Future scenarios and uncited current growth claims are omitted. The physical inference that annual energy cannot establish mass-normalized power or entropy production is dimensional, not another conclusion attributed to the IEA.

Q08 Task specific neural rhythms

Niko A. Busch, Julien Dubois, and Rufin VanRullen. **The Phase of Ongoing EEG Oscillations Predicts Visual Perception.** *Journal of Neuroscience* 29(24), 7869–7876 (2009). DOI 10.1523/JNEUROSCI.0113-09.2009; primary article at PMC.

Type and locator: Primary EEG/perceptual experiment; publisher/PMC-indexed abstract, introduction, and discussion inspected. Direct opens intermittently returned 403 or a browser-verification page. Near-threshold flash detection varied with prestimulus oscillatory phase, with strongest effects in theta/alpha bands.

Use and limit: The reader states task-specific association, not a frame-by-frame theory of all consciousness, causal proof from this experiment, or evidence of empty experiential intervals. The original 10–40 Hz universal frame-rate claim is withdrawn. No inference about AI phenomenology follows. The study's numerical performance-effect estimate is not imported.

Q09 Evolutionary contingency

Zachary D. Blount, Christina Z. Borland, and Richard E. Lenski. **Historical contingency and the evolution of a key innovation in an experimental population of Escherichia coli.** *PNAS* 105(23), 7899–7906 (2008). DOI 10.1073/pnas.0803151105. Author-hosted paper.

Type and locator: Primary evolution/replay experiment; publisher-indexed abstract and paper excerpt inspected; direct author-PDF fetch returned 403.

Use and limit: One of twelve initially identical populations evolved aerobic citrate use **by**, not after, 31,500 generations in the report. Replay experiments support historical contingency. This is a report-specific result, not a claim about all populations for all subsequent time. Divergent outcomes in a finite experiment do not establish universal nonergodicity; that term requires a specified dynamical model and measure.

Q10 Emergence

P. W. Anderson. **More Is Different.** *Science* 177(4047), 393–396 (1972). DOI 10.1126/science.177.4047.393. Primary essay scan.

Type and locator: Author's theoretical/conceptual essay. Relevant pp. 393–394 inspected in the complete scan. Anderson distinguishes reductionism from the claim that knowledge of fundamental laws automatically reconstructs higher-scale explanations and discusses broken symmetry.

Use and limit: Supports the need for level-specific concepts and collective description. The reader does not turn the essay into a mathematical proof that every possible higher-level property is underivable, or suggest higher-scale behavior violates fundamental laws.

Q11 Terrestrial entropy accounting

Emory F. Bunn. **Evolution and the second law of thermodynamics.** *American Journal of Physics* 77, 922–925 (2009). DOI 10.1119/1.3119513; author preprint; full text.

Type and locator: Original quantitative pedagogical analysis. Abstract and relevant solar/terrestrial energy-accounting text inspected; arXiv full text accessible, institutional mirror returned 502.

Use and limit: Supports the compatibility of local biological ordering with entropy increase in a larger accounting. The claim that ordinary downstream use of emitted light does not accelerate solar core fuel consumption is our boundary/causality inference, together with Q02. It is not a numerical result of this paper or a claim that the Sun and Earth have no gravitational or electromagnetic interaction at all. No cosmic lifetime calculation is offered.

Q12 US server scope audit only

Arman Shehabi et al. **2024 United States Data Center Energy Usage Report.** Lawrence Berkeley National Laboratory, LBNL-2001637 (December 2024). DOI 10.71468/P1WC7Q. Institutional record; accessible report PDF.

Type and locator: Primary institutional bottom-up analysis. Relevant text in §§2–5 inspected, especially printed pp. 49–53, Figures 5.1 and 5.6 descriptions. Historical estimates end in 2023; subsequent years through 2028 are scenario ranges. Direct server electricity is distinguished from storage, networks, and facility infrastructure.

Decision and unresolved detail: The exact 53–76 TWh endpoints in the original were located in secondary accounts describing US AI servers, not a global AI total. They were not independently recovered as a numerical primary table or underlying series in this pass. Therefore the range is removed, not relabeled as a verified global observation. The original PDF URL without _1 returned 429; the alternative file linked by the institutional record was readable. No precise chart values are inferred from unreadable screenshot output.

Q13 Historical perceptual citation audit only

Francisco J. Varela, Alfredo Toro, E. Roy John, and Eric L. Schwartz. **Perceptual framing and cortical alpha rhythm.** *Neuropsychologia* 19(5), 675–686 (1981). DOI 10.1016/0028-3932(81)90005-1; PubMed record.

Access and decision: Bibliographic record verified; PubMed has no abstract and full experimental text was not acquired in this pass. This paper is not used as proof of a 10–40 Hz universal consciousness rate. VanRullen and Koch (2003) is a review, not the primary experimental replacement. Q08 provides a directly scoped primary finding without claiming discrete phenomenal frames.

Q14 Entropy balance and conditional instabilities

Ilya Prigogine. **Time, Structure and Fluctuations.** Nobel Lecture, 8 December 1977, pp. 263–285. Official lecture. Revised publication: *Science* 201(4358), 777–785 (1978), DOI 10.1126/science.201.4358.777; publication abstract.

Type and locator: Primary author exposition of the theoretical program, not independent validation. Relevant text from §§2–4 inspected in indexed copies: entropy exchange versus internal production; stability dependence on kinetic form; chemical oscillations and bifurcations. Official indexed §4 text includes the successive-bifurcation example on p. 273. Direct official PDF fetch returned 403; university reprint timed out. Access copies: primary-lecture transcription, especially §3 pp. 268–270 and §4; primary-PDF mirror, indexed p. 265 for entropy balance. These reproduce the primary author's text and are not independent evidentiary sources.

Use and limit: Supports a bounded physical account, never a measured law of arguments, divorce, war, or civilizations. Distinguishing entropy change from production and exchange is essential. Dimensional consequences below are calculations from definitions; no universal power-to-entropy conversion is claimed. No general catastrophic-release theorem is attributed to Prigogine.

Q15 Multiple nucleosynthetic routes

H. Reeves, W. A. Fowler, and F. Hoyle. **Galactic Cosmic Ray Origin of Li, Be and B in Stars.** *Nature* 226, 727–729 (1970). DOI 10.1038/226727a0.

Type and locator: Original theoretical study, publisher abstract and metadata inspected. It examines production of these light elements through cosmic-ray interactions with interstellar material.

Use and limit: Establishes that the origin problem includes processes other than ordinary stellar fusion. The reader does not claim that all lithium, beryllium, or boron has a single cosmic-ray origin, or use this historical analysis as a current quantitative inventory. Its narrow role is to prevent “all above helium is stellar waste” from passing as a complete account.

Calculations and dimensional checks

Energy versus entropy: W = J/s. Thus P/m has units J/(s·kg), whereas an entropy-production rate divided by mass has units J/(K·s·kg). Entropy change and entropy production are also distinct in an open system: the change includes exchanges across the boundary as well as internal production. For the illustrative special case of steady heat transfer P from a hot reservoir at T_h to a cold reservoir at T_c, with no other changes, the combined reservoir entropy-production rate is $P(1/T_c - 1/T_h)$. This is an example of the model information needed; it is not applied as a blanket formula to radiation, organisms, or data centres.

Dated electricity total: 415 TWh × 10^{12} W/TW × 3600 s/h = 1.494 × 10^{18} J. Calendar 2024 had 366 days = 8784 hours. Dividing gives approximately 47.2450 GW average electrical input (unrounded: 47.2449908925 GW). This arithmetic is not used as an entropy estimate and is not a power-density comparison; no system mass is supplied. The reader retains the primary TWh estimate without this optional derived number.

Adult resting brain example: Q06 Table 3 gives mean brain mass 1.33 kg and mean measured resting expenditure 1575 kcal/day; Table 2 gives mean body mass 73.7 kg. Using the evaluated brain coefficient 240 kcal/(kg·day): 1.33/73.7 ≈ 1.80% of body mass, and (1.33 × 240)/1575 ≈ 20.27% of resting expenditure. This is a ratio-of-cohort-means illustration with a modeled organ coefficient, not each person's separately measured brain energy fraction. Specific-rate conversion gives (240 × 4184)/86400 ≈ 11.62 W/kg for brain and (440 × 4184)/86400 ≈ 21.31 W/kg for heart/kidneys; neither is entropy production.

Remaining questions and exclusions

- No comparable dataset or entropy balances establish a universal increase at every rung, or superiority of every bacterium over every nonliving reaction system. Both universal claims are withdrawn rather than assigned a softer tier.
- No system-specific mechanism connects the second law or MEPP to the necessity or generic comparative likelihood of life, brains, or AI. P03/P04/P07/P08 retain their own assumptions and scope.
- No quantitative model links terrestrial electricity use to stellar correction, a Fermi explanation, or a common physical scale law for interpersonal conflict and war. These are explicitly literary/critical material in Chapter 4, not pending predictions.
- The exact primary provenance of the 53–76 TWh endpoints remains unresolved; geographic/equipment/time-boundary problems are documented and the figure is not retained.

- No AI deployment was inspected. Context-window limits, sessions, process lifecycle, persistence, and experience cannot be equated from the manuscript. Neither phenomenal presence nor absence is asserted.
- No universal conscious sampling rate or physical relational-entropy quantum has been established. Q08 preserves a specific experiment; the Trinket remains a conceptual accounting proposal.
- Volumes 1, 2, 4 and 5 supply continuity only. This work makes no claim of independently validating their conceptual units or measurement proposals.

Supplemental definition notes

Added in Edition 2.5 for the biological column of the star-as-host table. They support the biological descriptions only, not the stellar mapping, and do not renumber the inherited P/Q references.

D1. National Human Genome Research Institute. Virus. *Talking Glossary of Genomic and Genetic Terms.* https://www.genome.gov/genetics-glossary/Virus. Supports: a virus cannot replicate alone and uses components of host cells to make copies of itself.

D2. National Cancer Institute. Immune response. *NCI Dictionary of Cancer Terms.* https://www.cancer.gov/publications/dictionaries/cancer-terms/def/immune-response. Supports: a bounded description of host defenses against pathogens.