ANNALS OF THE CHRYSENE FORMALISM

ORTHOGONAL REVIEW RECORD

Information-Theoretic Mechanics of Survival in Maximum-Entropy Environments

Static Minimax Disturbance Attenuation, Coordination-Deficit Costs,
and the Placed Source as Categorical Right Adjoint

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Declared review status

This is an AI-assisted simulated orthogonal review, not independently appointed human peer review. Separate mathematics and chemistry passes inform the revision. Concordance compares the manuscript, inherited referee report, executable computations and formal companion files. Revision responses describe prepared changes rather than unprovided author statements.

> **Scope of Review**
>
> The controlling input is Article 97's supplied `main.tex`. Its historical report and verification and formal-proof dossiers are evidence to audit, not automatic certification. Finite combinatorics, graph spectra, probabilistic control, categories, thermodynamic work and molecular realization require distinct arguments.

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1 Source record and historical review

The supplied referee report is preserved unaltered as

`provenance/Article97_Prior_Referee_Source.tex`.

Its provisional Volume 1 Number 5 pagination, October 2026 date and verdict "Accept with Minor Revisions (One Exact Spectral Constant Refinement & Three Algebraic Enrichments)" are historical. They are not the disposition of the present audit. The earlier report requested a radical expression for the tetracene gap, a plaquette parity statement, an adjunction monad/comonad clarification and an asymptotic surface-capacity argument. These are retained as useful questions, but neither the prior verdict nor its verification claims substitute for the current checks.

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2 Mathematical validity review

> **Mathematical disposition**
>
> Major constructive revision is warranted. The finite combinatorics, graph invariants and support-poset adjunction survive. Several control, variational and physical conclusions require narrower statements or additional hypotheses.

2.1 M1 Thermal risk and a defined minimax problem

The original definition identifies twice a worst-case error probability with an $\mathcal{H}_\infty$ transfer norm without an input/output operator or specified adversarial disturbance family. Boltzmann equilibrium alone does not provide the claimed supremum, and an unbounded adverse bias can defeat any finite control.

Revision response. The revision separates the equilibrium two-state error $q(u) = (1 + e^{u/k_B T})^{-1}$ from a defined memoryless control surrogate. Its diagonal gains give a genuine induced norm for that surrogate, not a derived chemical transfer function. The adversary is a square-integrable input to that surrogate; it is not an unspecified shift of the Gibbs energy difference. Under a total nonnegative control budget, equal allocation minimizes the largest decreasing contact gain. Continuous-time static gain is not assigned a finite $\mathcal{H}_2$ norm. Finite bias retains full support and positive entropy; the feedback mutual-information identity is not imposed on every open-loop reset.

2.2 M2 Spectral constants and perturbation domain

The correct computed zero-field gaps in positive hopping units are approximately 1.0402775762 for chrysene and 0.5899257986 for tetracene. Their ratio is 1.7634041072, rounding to 1.7634, not 1.7633. The matching counts eight and five remain valid. The inherited proof does not establish ordering at every electric field or isolation of directional channels.

Revision response. The revision retains the exact graph invariants and tetracene radical, computes determinants independently, and distinguishes numerical eigenvalues from exact statements. Weyl's bound gives

$$\Delta_c(V_c) - \Delta_t(V_t) \geq \Delta_c(0) - \Delta_t(0) - 2(\|V_c\| + \|V_t\|).$$

Strict ordering follows when this lower bound is positive. Orthogonality of distinct Hermitian eigenvectors is not promoted to physical channel isolation; the latter needs invariant-subspace or realization assumptions.

2.3 M3 Tripartite admissibility and minimizers

The sum of three $0/+\infty$ indicators is not a differentiable Euler–Lagrange functional. Its zero set may contain many triples; the original uniqueness assertion is false. Empty closed surfaces must be excluded explicitly.

Revision response. The revised proposition states nonempty chain, surface and scaffold predicates and assumes a nonempty feasible set. The minimizers are exactly the product of the three admissible classes and have value zero. Every inadmissible triple has infinite formal cost by definition. No unique geometry or spontaneous physical unfolding is inferred.

2.4 M4 Capacity, rounding and the full length range

A radius and local alphabets do not universally force an interior cardinality below a boundary cardinality. The original example rounded a radius before applying a floor, and the asymptotic limit alone did not prove an inequality at every finite length.

Revision response. The revised example uses the corrected conditional containment length $L = 233$, fixed lattice size 54, and the unrounded law $r(L) = 0.89923\sqrt{L} - 4$. It yields 2377 surface tiles, 682 internal capacity bits and 4754 surface capacity bits. For the entire integer range $L \geq 233$, the revision bounds the floor by one unit and defines

$$Q(L) = \frac{8\pi}{a}(c\sqrt{L} - d_b)^2 - 2L - 218.$$

It establishes $Q(233) > 0$ and $Q'(L) > 0$ throughout that range using explicit conservative bounds. This proves the capacity inequality without relying on a numerical sweep. The asymptotic utilization

$a/(4\pi c^2)$ is separate and assumes fixed or sublinear lattice size. Cardinal dominance permits an abstract injection but does not supply a molecular encoder.

2.5 M5 Support-poset adjunction and object counts

The source's thin-category adjunction is valid when formulated with a discrete species category and reverse-inclusion support fibres. At height six the placed category has $3^6 = 729$ objects; 32 is the number of registry words per species, not the number of category objects. Each support fibre has 2^{31} supports containing its prescribed target.

Revision response. Full-support inclusion is left adjoint to species projection with a stipulated target section. The unit is identity and the counit is full support to the chosen support; thinness yields naturality and the triangle identities. The unit being an isomorphism makes the left adjoint fully faithful, not the right adjoint. The revision uses the correct orientation and isolates any thermodynamic implementation from the categorical result.

2.6 M6 Slack and additive projection

The binomial formula describes a specified occupation model, not arbitrary void injection. Its logarithm is a maximum or uniform entropy. Monotonic state count does not alone establish a physical second law. The projection $\mathbb{F}_2^3 \to \mathbb{F}_2^2$ is additive-linear, not a unital field homomorphism from GF(8) to GF(4).

Revision response. The revision states the occupancy and uniformity conventions, prescribed contact-deficit scores and saturation assumption. The projection remains surjective with a two-element kernel. Zero graph deficit at a complete site is conditional on all six contacts being present; their molecular realization is distinct.

3 Concordance review

> **Concordance disposition**
>
> Three recommendations correct cross-article dependencies and the evidence attributed to the inherited code and formal dossier. Historical artifacts remain available as superseded provenance.

3.1 C1 Cross-article and package consistency

Article 94's corrected geometry uses the conditional 233-base-pair example. Article 96 distinguishes finite-bias distributions, replacement channels, persistent sink coherence and cyclic work protocols. Earlier framework proposals should not be treated as newly verified physical results.

Revision response. The revised abstract, figures, conclusion and hypothesis register use the corrected thresholds and finite-bias scope. The OJS abstract is derived from the final manuscript, and the companions state the same assumptions and numerical benchmarks.

3.2 C2 Executable evidence

The supplied Python fails at line 146 on the assertion that the gap ratio rounds to 1.7633. Several advertised tests were absent: actual hom-set and triangle construction, tripartite admissibility, the full-range capacity bound, occupied-box completeness, perturbation checks and plaquette parity. Emitting a macro is not checking its theorem.

Revision response. The final suite replaces unsupported assertions with explicit finite checks and negative controls. It labels floating calculations separately from exact checks and does not use a finite sweep as the sole proof of an infinite-range claim. The manuscript supplies the analytic capacity argument.

3.3 C3 Lean provenance and scope

Fresh Lean 4.24 compilation of the inherited listing accepts two declarations but rejects `kekule_sachs_split` and `adjunction_triangles`; the failed declarations expose `sorryAx` in the diagnostic audit. The surviving function identity does not encode the manuscript's support-poset categories or establish the complete advertised adjunction.

Revision response. The final formal companion uses explicit finite models, support hom-predicates and checked identities, with dependency audits and no reliance on failed inherited declarations. Graph-count claims require graph certificates rather than an identity about squares alone. The companion states exactly which finite consequences it proves.

4 Chemistry and physical interpretation review

> **Chemistry disposition**
>
> Eight recommendations separate the valid finite model from a molecular implementation. Physical assumptions are retained as explicit hypotheses or proposed tests, not as consequences of graph arithmetic or category theory.

4.1 H1 Coordination score and conservation of matter

The score $\mathcal{F}_{\mathrm{topo}} = \sum_v \eta(v)$ counts model contact deficits. It is dimensionless and is not by itself a thermodynamic free energy. Comparing $6\phi L^3$ and $4\phi L^2$ changes the number of sites; the difference cannot prove a mass-conserving dimensional transition.

Revision response. The revision describes prescribed domain families and identifies the score's units. A physical comparison would need a common material budget, chemical potentials, bond and solvent energies, and entropy. The arithmetic inequality and additive projection remain intact.

4.2 H2 Graph spectra and chemical survival

The two graph matching counts and zero-field Hückel gaps do not establish universal chemical stability, a global ordering under electric fields, or channel orthogonality. Hopping is specified by

a positive magnitude. Substitution, aggregation, screening, ionization and reaction kinetics are outside the bare-graph calculation.

Revision response. The revision limits field robustness to a stated perturbation bound and removes unsupported universal channel and survival conclusions. Clar sextets motivate chemical hypotheses. The unsupported universal "photo-cleavage" and unique-survivor language is removed. Oxygen-, light- and substitution-dependent reaction mechanisms require separate evidence.

4.3 H3 Equilibrium bias and robust control

A logistic Boltzmann population uses an adverse-minus-target free-energy difference, equal degeneracies and adequate relaxation. An activation barrier affects rates but does not alone fix equilibrium populations. A normalized error probability is not an induced L^2 gain, an $\mathcal{H}_\infty$ transfer norm or an $\mathcal{H}_2$ impurity norm.

Revision response. The revised model uses the logistic probability to define a diagonal memoryless input/output operator and evaluates its induced gain directly. The resulting static minimax theorem is exact for that surrogate, with its physical realization kept separate. Stark calibration requires differences in state-dependent dipoles and polarizabilities. Imported yields are model outputs, not measured purity.

4.4 H4 Support and entropy at finite fidelity

At finite positive temperature and finite bias, both binary states have positive probability. Thus all independent-contact words remain in support even at high target fidelity. Log-cardinality equals Shannon entropy only for a uniform law.

Revision response. The revision retains full support and positive residual entropy at finite-bias benchmarks, and reserves zero slack for an ideal limiting or explicit support-restricted model. It distinguishes maximum entropy, actual entropy and feedback conditional entropy; an open-loop reset need not store information about its input.

4.5 H5 Work cost requires a physical protocol

An abstract category has no bath or work reservoir. Under degenerate endpoint Hamiltonians, a uniformly occupied D-state ensemble reset into a support of at most m states has work bounded below by $k_B T \ln(D/m)$. A uniform final distribution makes the entropy bound sharp; a nonuniform output can require more work. General endpoint Hamiltonians require the corresponding nonequilibrium free-energy difference.

Revision response. The revision attaches the bound to a separate isothermal implementation with complete cyclic work accounting. It distinguishes work from heat when internal energy changes, and does not infer reversibility or equality at finite time. The category supplies the support relation, not a measured thermodynamic cost.

4.6 H6 Tripartite feasibility versus morphology

A $0/+\infty$ objective that defines admissibility by the presence of a sequence, closed boundary and scaffold encodes those requirements; it does not derive their emergence. Many distinct admissible

triples can attain zero, and ordinary Euler–Lagrange differentiation does not apply.

Revision response. The revision states nonempty admissibility predicates and a feasibility equivalence, permits multiple minimizers, and removes the claim of unique morphology or infinite physical buckling energy for every unbraced membrane. Physical selection would need curvature elasticity, tension, osmotic pressure and adhesion.

4.7 H7 Surface-code capacity and gravitational analogy

The count $2\lfloor A/a_{\mathrm{lip}} \rfloor$ is a stipulated capacity for distinguishable four-state surface tiles. It is not gravitational Bekenstein–Hawking entropy, and a cardinality inequality alone does not construct a molecular encoding.

Revision response. The revision presents a conditional surface-code budget. Internal log-cardinality is an upper bound on entropy unless uniform independent occupancy is stipulated. The radius law, fixed lattice size and tile area are explicit model inputs; asymptotic behavior is distinguished from a finite-threshold proof. Any holographic language is an analogy, not a gravitational derivation.

4.8 H8 Empirical closure

A molecular implementation requires characterized substituted-chrysene identities, purity and aggregation; registry distributions and correlations; local-field biases, relaxation and leakage; spectra and degradation under controlled environments; membrane area, distinguishable states and mechanical response; and full-cycle work or heat measurements.

Revision response. These are proposed tests rather than reported results. A demand for a complete experimental origin-of-life demonstration before publishing a conditional mathematical model is not adopted. Instead, the paper makes model conclusions precise and removes physical assertions not established by those conclusions.

5 Revision decisions and evidence boundaries

Prepared revision

The finite framework is retained with corrected statements. No recommendation requiring a completed molecular origin-of-life experiment is adopted as a prerequisite for a conditional mathematical paper. This scope decision does not preserve unsupported claims of unique morphology, universal survival, gravitational entropy or unconstrained physical control.

The revised paper's results are organized by evidence: exact combinatorial and categorical identities; analytic implications under stated assumptions; numerical graph benchmarks; and proposed physical realization. The review record does not confer editorial acceptance, external peer review or experimental validation.

6 Final verification and review closure

The replacement Python suite executes 64,678 explicit checks in each of normal and optimized modes: 63,888 exact checks and 790 numerical checks, including ten negative controls. The two modes have identical outputs. The exact graph work includes independent matching and determinant checks and rational Sturm bounds: chrysene's gap lies in $(1.0402, 1.0403)$ and tetracene's in $(0.5899, 0.5900)$ in positive hopping units. The printed decimal ratio is a numerical benchmark, not a symbolic identity.

Lean 4.24 freshly compiles 43 named theorems. Forty are axiom-free; three use the standard logical axiom `propext`. There are no `sorry`, native-decision or user-added axioms. The actual arbitrary support-poset adjunction has twelve general declarations, all axiom-free. Other certificates have the finite scope declared in the companion. Lean does not formalize the Sturm calculation, spectral perturbation analysis, continuous control problem, thermodynamics or molecular realization.

The executable source, embedded listings and audit records are supplied in the verification and formal-proof companions. General analytic claims rely on their manuscript proofs, not on the number of finite checks. These results supersede the failed inherited evidence without treating every empirical or infinite-dimensional claim as formally certified. Focused post-revision mathematics and chemistry checks support the revised statements. Minor wording clarifications about admissible products, entropy bounds, equal Gibbs degeneracy and work/heat accounting were integrated. No substantive review blocker remains.

7 Selected external references for interpretation

These sources support the distinctions made in the chemistry review; none verifies the proposed substituted-chrysene assembly.

1. Reeb, D., and Wolf, M. (2014). An improved Landauer principle with finite-size corrections. *New Journal of Physics* 16, 103011. `https://doi.org/10.1088/1367-2630/16/10/103011`.

2. Bérut, A., et al. (2012). Experimental verification of Landauer's principle linking information and thermodynamics. *Nature* 483, 187–189. `https://doi.org/10.1038/nature10872`.

3. Helfrich, W. (1973). Elastic properties of lipid bilayers: theory and possible experiments. *Zeitschrift für Naturforschung C* 28, 693–703. `https://doi.org/10.1515/znc-1973-11-1209`.

4. Bekenstein, J. D. (1973). Black holes and entropy. *Physical Review D* 7, 2333. `https://doi.org/10.1103/PhysRevD.7.2333`.

5. Hawking, S. W. (1976). Black holes and thermodynamics. *Physical Review D* 13, 191. `https://doi.org/10.1103/PhysRevD.13.191`.