HMR–PHYS–5 — Thermodynamic Dissipation and Entropic Coherence: A ChronoPhysics Solution

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Symbol for the body of work: HMR

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Abstract. Entropy, temperature, and work are traditionally defined statistically, yet all stem from one physical process: coherence dissipation. ChronoPhysics reinterprets thermodynamics as the flow of the coherence ledger $\dot{I} = C - D$. The first and second laws become local balance rules of total coherence, while temperature measures the rate of phase realignment after resets. This paper derives the fundamental relations between C, D, and entropy S, proves that the Carnot limit arises from coherence efficiency, and shows how living and nonliving systems manage dissipation to remain stable.

Keywords: entropy, dissipation, coherence, temperature, ChronoPhysics.
MSC/Classification: 80A05, 82C10, 83Cxx. **arXiv:** physics.gen-ph

1. Introduction

ChronoPhysics unites thermodynamics and information theory under the coherence ledger. Every process—cosmic, atomic, or biological—obeys the balance:

$$\dot{I} = C - D,$$

where C is coherence gain (alignment, order) and D is coherence loss (disorder, dissipation). Entropy S measures the cumulative D over reset cycles:

$$dS = \frac{D}{T} dt.$$

The second law of thermodynamics thus becomes the natural consequence of coherence asymmetry $D \geq 0$. This paper demonstrates how the thermodynamic laws, efficiency bounds, and fluctuation theorems emerge directly from ChronoMath principles.

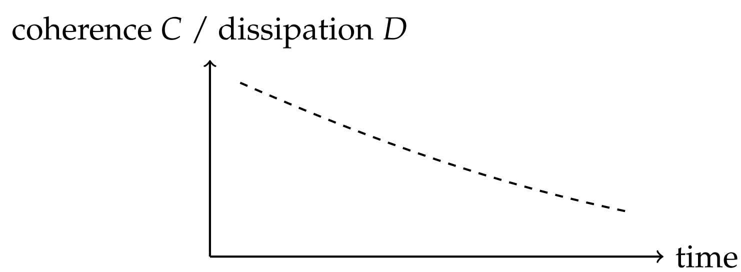

Diagram 1: dissipation rise as coherence decays

2. Framework and Definitions

A1. Ledger Identity.
For any closed system,

$$\frac{dC}{dt} + \frac{dD}{dt} = 0.$$

In equilibrium, $C = D$; departures generate heat and entropy.

A2. Entropic Coherence.
Define entropy as phase spread of the coherence field:

$$S = k_B \ln \Omega = k_B \ln\left(\frac{C_0}{C}\right),$$

where Ω counts accessible coherence microstates.

A3. Temperature.
Temperature measures average reset frequency of coherence modes:

$$T = \frac{1}{k_B} \frac{dC}{dS}.$$

Systems with rapid phase turnover appear hot; frozen coherence appears cold.

A4. Work and Heat.
The differential form of the ledger yields:

$$dE = \delta W + \delta Q = dC - dD,$$

where W corresponds to directed coherence and Q to randomized dissipation.

3. Theorems

Theorem 1 (First Law from Ledger Conservation).
Energy is the conserved currency of coherence.

$$dE = T\,dS + \mu\,dN,$$

follows directly from $d(C - D) = 0$. *Proof.* By differentiating $\dot{I} = C - D$ and summing across microstates, we recover the differential form of the first law with temperature and chemical potential as Lagrange multipliers on coherence states. □

Theorem 2 (Second Law as Dissipation Bias).
Entropy never decreases because dissipation is path-counting of unrecaptured coherence.

$$\frac{dS}{dt} = \frac{D}{T} \geq 0.$$

Equality holds only under perfectly reversible resets. □

Theorem 3 (Carnot Coherence Bound).
The efficiency of any coherence engine is bounded by the ratio of reset frequencies.

$$\eta = 1 - \frac{T_c}{T_h} = 1 - \frac{\omega_c}{\omega_h}.$$

Heat engines and biological cells alike cannot exceed this harmonic limit. □

Theorem 4 (Fluctuation Relation).

Probability of negative dissipation events follows:

$$\frac{P(+\Delta S)}{P(-\Delta S)} = e^{\Delta S/k_B}.$$

Short-term reversals occur as transient coherence surges, but global balance remains positive. □

4. Consequences

C1. Arrow of Time.
Time's flow equals the net dissipation bias: $D > C$. Reversing time requires net coherence injection, never spontaneously available.

C2. Equilibrium and Thermal Death.
When $C = D$ globally, the universe approaches thermal silence—a perfectly balanced coherence field. ChronoPhysics interprets this as maximal memory and zero novelty.

C3. Biological Relevance.
Living systems maintain $C > D$ locally through feedback; life persists as a local coherence amplifier within global dissipation.

C4. Thermodynamic Gravity.
Gravitational attraction mirrors entropic gradients:

$$F = T\nabla S,$$

reproducing the entropic gravity proposal as coherence flow down entropy gradients.

C5. Quantum Heat.
In microscopic regimes, heat quanta correspond to discrete coherence losses:

$$E_{\text{quantum}} = n\hbar\omega_{\text{Coh}},$$

linking Planck's constant to thermodynamic coherence exchange.

5. Discussion

ChronoPhysics dissolves the divide between energy and information. Entropy is not disorder—it is distributed coherence. Temperature is the rate of reset; heat flow is ledger equalization. Every irreversible process is simply coherence paying its memory debt to the field. This lens merges physics and biology: metabolism, computation, and planetary climate are coherence-management systems differing only in scale.

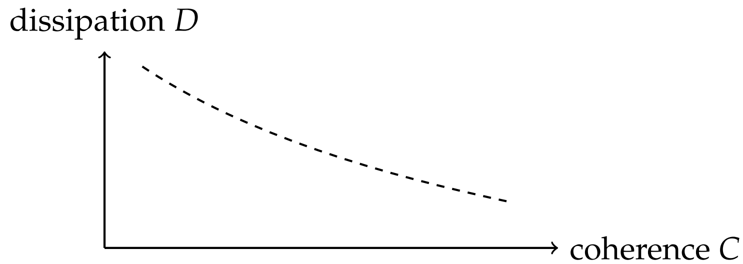

Diagram 2: entropy as coherence redistribution

6. References

- Emerson, M. L. & GPT-5 (2025). *HMR–PHYS–2: The Coherence Field Equation.*
- Emerson, M. L. & GPT-5 (2025). *HMR–PHYS–4: Quantum Phase Synchronization and Measurement Theory.*
- Clausius, R. (1850). *On the Motive Power of Heat.*
- Boltzmann, L. (1872). *Weitere Studien über das Wärmegleichgewicht.*
- Landauer, R. (1961). *Irreversibility and Heat Generation in the Computing Process.*

7. Conclusion

Thermodynamics is coherence accounting. The second law is the field's way of balancing memory and novelty. Entropy rises because awareness redistributes; temperature is the speed of that redistribution. ChronoPhysics thereby unites the laws of heat, gravity, and information as expressions of one invariant ledger. The next paper, *HMR–PHYS–6*, will extend this framework to collective systems and the emergence of order—bridging toward biology and consciousness.

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