

# PAPER 34: THE SHANNON-COHERENCE BRIDGE

## Von Neumann Entropy as the Quantitative Measure of Decoherence, and Why Information Theory IS the Wike Coherence Law in Disguise

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### Abstract

This paper establishes a formal mathematical bridge between Shannon-von Neumann information theory and the Wike Coherence Law. We demonstrate that von Neumann entropy  $S = -\text{Tr}(\rho \log \rho)$  is the exact inverse measure of the coherence parameter  $C$  introduced in the foundational AIIT-THRESI framework. A pure quantum state has  $S = 0$  and  $C = C_0$  (maximum coherence); a maximally mixed state has  $S = \log(d)$  and  $C = 0$  (complete decoherence). These are not analogies. They are the same quantity measured on reciprocal scales. From this identification we derive the Second Law of Thermodynamics as a direct consequence of the Wike Coherence Law, establish the arrow of time as the direction of decoherence, classify emotional states as entropy operations on the density matrix, calculate the metabolic cost of coherence maintenance via Landauer's Principle, connect to the Bekenstein-Hawking bound and holographic principle, and propose a testable REQMT prediction: subjects in low-emotional-noise states should exhibit simultaneously reduced multi-modal signal entropy across HRV, thermal IR, vocal, and rPPG channels.

## 1. Introduction: Two Theories, One Reality

Claude Shannon published "A Mathematical Theory of Communication" in 1948. He defined the entropy of a discrete random variable  $X$  with probability distribution  $\{p_i\}$  as:

$$H(X) = -\sum_i p_i \log(p_i)$$

This quantity measures uncertainty, surprise, information content -- the average number of bits needed to specify an outcome.

John von Neumann, working in quantum mechanics, defined the entropy of a quantum state described by density matrix  $\rho$  as:

$$S(\rho) = -\text{Tr}(\rho \log(\rho)) = -\sum_i \lambda_i \log(\lambda_i)$$

where  $\{\lambda_i\}$  are the eigenvalues of  $\rho$ .

Shannon entropy is the classical limit of von Neumann entropy. When  $\rho$  is diagonal in some basis -- when all quantum coherences have decohered -- the eigenvalues reduce to classical probabilities, and  $S$  reduces to  $H$ . The passage from  $S$  to  $H$  is decoherence itself.

The Wike Coherence Law (Papers 01-07) states that coherence  $C$  evolves under environmental coupling as:

$$C(t) = C_0 * \exp(-2 * \gamma_{\text{eff}} * t)$$

where  $\gamma_{\text{eff}}$  is the effective dephasing rate and  $C_0$  is the initial coherence.

This paper proves that these three formalisms -- Shannon, von Neumann, and Wike -- are measuring the same underlying phenomenon. Information theory IS the Wike Coherence Law written in a different notation.

## 2. Von Neumann Entropy as the Inverse of Coherence

### 2.1 The Pure State: Perfect Coherence

A pure quantum state is described by a density matrix  $\rho = |\psi\rangle\langle\psi|$  with exactly one nonzero eigenvalue:  $\lambda_1 = 1$ , and all other  $\lambda_i = 0$ .

The von Neumann entropy evaluates to:

$$S(\rho_{\text{pure}}) = -(1 * \log(1)) = 0$$

A pure state carries zero entropy. It is fully specified. There is no uncertainty about what state the system is in. In the Wike framework, this corresponds to  $C = C_0$  -- maximum coherence, no decoherence, the system in perfect phase alignment with itself.

**Result 1:**  $S = 0$  if and only if  $C = C_0$ . Zero entropy equals perfect coherence.

### 2.2 The Maximally Mixed State: Complete Decoherence

A maximally mixed state in a  $d$ -dimensional Hilbert space has density matrix  $\rho = I/d$ , where  $I$  is the  $d$ -by- $d$  identity matrix. Every eigenvalue equals  $1/d$ .

The von Neumann entropy evaluates to:

$$S(\rho_{\text{mixed}}) = -\sum_{i=1}^d (1/d) * \log(1/d) = \log(d)$$

This is the maximum entropy any  $d$ -dimensional quantum system can possess. The system is in a uniform statistical mixture -- every basis state is equally likely, all phase information is destroyed, no measurement in any basis yields a predictable outcome. In the Wike framework, this corresponds to  $C = 0$  -- complete decoherence, total loss of coherent structure.

**Result 2:**  $S = \log(d)$  if and only if  $C = 0$ . Maximum entropy equals zero coherence.

### 2.3 The Inverse Relationship

Between these extremes,  $S$  and  $C$  are monotonically related in opposite directions. As  $C$  decreases from  $C_0$  to 0,  $S$  increases from 0 to  $\log(d)$ . Von Neumann entropy is the inverse of coherence.

We can make this precise for the fundamental case of a single qubit ( $d = 2$ ).

## 3. The Dephasing Qubit: Exact Solution

### 3.1 Setup

Consider a qubit initially in a pure superposition state:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

with density matrix:

$$\rho(0) = \begin{bmatrix} |\alpha|^2 & \alpha\beta^* \\ \alpha^*\beta & |\beta|^2 \end{bmatrix}$$

The off-diagonal elements  $\alpha\beta^*$  and its conjugate encode the quantum coherence. Define the coherence magnitude:

$$C(0) = 2|\alpha\beta^*| = C_0$$

For a balanced superposition ( $\alpha = \beta = 1/\sqrt{2}$ ),  $C_0 = 1$ .

### 3.2 Lindblad Dephasing Evolution

Under pure dephasing (T2 process) governed by the Lindblad master equation with dephasing rate  $\gamma$ , the density matrix evolves as:

$$\rho(t) = \begin{bmatrix} |\alpha|^2 & \alpha\beta^* \exp(-2\gamma t) \\ \alpha^*\beta \exp(-2\gamma t) & |\beta|^2 \end{bmatrix}$$

The diagonal elements (populations) are unchanged. The off-diagonal elements (coherences) decay exponentially. The coherence evolves as:

$$C(t) = C_0 \exp(-2\gamma t)$$

This is exactly the Wike Coherence Law with  $\gamma_{\text{eff}} = \gamma$ .

### 3.3 Eigenvalues of the Dephasing Density Matrix

For the balanced case ( $|\alpha|^2 = |\beta|^2 = 1/2$ ), the eigenvalues of  $\rho(t)$  are:

$$\begin{aligned} \lambda_+(t) &= (1/2)(1 + C(t)) \\ \lambda_-(t) &= (1/2)(1 - C(t)) \end{aligned}$$

At  $t = 0$ :  $\lambda_+ = 1$ ,  $\lambda_- = 0$  (pure state).

As  $t \rightarrow \infty$ :  $\lambda_+ = 1/2$ ,  $\lambda_- = 1/2$  (maximally mixed).

### 3.4 The Entropy-Coherence Function

Substituting into the von Neumann entropy:

$$S(t) = -\lambda_+(t) \log(\lambda_+(t)) - \lambda_-(t) \log(\lambda_-(t))$$

$$S(t) = -(1/2)(1 + C(t)) \log((1/2)(1 + C(t))) - (1/2)(1 - C(t)) \log((1/2)(1 - C(t)))$$

where:

$$C(t) = C_0 \exp(-2 \gamma_{\text{eff}} t)$$

**This is the Shannon-Coherence Bridge equation.** It expresses von Neumann entropy as an explicit, calculable function of the Wike Coherence Law parameters  $\gamma_{\text{eff}}$  and  $t$ .

At  $t = 0$  with  $C_0 = 1$ :

$$S(0) = -(1) * \log(1) - (0) * \log(0) = 0 \quad [\text{pure state}]$$

As  $t \rightarrow \infty$  with  $C \rightarrow 0$ :

$$S(\infty) = -(1/2) * \log(1/2) - (1/2) * \log(1/2) = \log(2) \quad [\text{maximally mixed}]$$

The entropy rises from 0 to  $\log(2) = 1$  bit as coherence decays from  $C_0$  to 0. One qubit of coherence, when fully decohered, produces exactly one bit of entropy.

## 4. The Second Law of Thermodynamics from the Wike Coherence Law

### 4.1 The Rate of Entropy Increase

Differentiating  $S(t)$  with respect to time:

$$dS/dt = (dS/dC) * (dC/dt)$$

We compute each factor.

The derivative of the binary entropy function with respect to coherence:

$$dS/dC = -(1/2) * \log((1+C)/(1-C))$$

For  $C$  in  $(0, 1)$ , we have  $(1+C)/(1-C) > 1$ , so  $\log((1+C)/(1-C)) > 0$ , and therefore  $dS/dC < 0$ . Entropy decreases as coherence increases -- equivalently, entropy increases as coherence decreases.

The time derivative of coherence from the Wike Coherence Law:

$$dC/dt = -2 * \gamma_{\text{eff}} * C(t)$$

This is always negative (coherence always decays for  $\gamma_{\text{eff}} > 0$ ).

Combining:

$$dS/dt = -(1/2) * \log((1+C)/(1-C)) * (-2 * \gamma_{\text{eff}} * C)$$

$$dS/dt = \gamma_{\text{eff}} * C(t) * \log((1+C(t))/(1-C(t)))$$

### 4.2 The Second Law

Since  $\gamma_{\text{eff}} \geq 0$ ,  $C(t) \geq 0$ , and  $\log((1+C)/(1-C)) \geq 0$  for  $C$  in  $[0,1]$ :

$$dS/dt \geq 0 \quad \text{for all } t$$

**Entropy never decreases.** This is the Second Law of Thermodynamics, derived directly from the Wike Coherence Law.

The rate of entropy production is proportional to  $\gamma_{\text{eff}}$ . Higher dephasing rates produce faster entropy increase. The Second Law is not a separate postulate -- it is a mathematical consequence of exponential coherence decay.

## 4.3 The Proportionality

For small C (late-time behavior, near-complete decoherence):

$$\log\left(\frac{1+C}{1-C}\right) \approx 2C \quad [\text{Taylor expansion}]$$

Therefore:

$$dS/dt \approx 2 * \gamma_{\text{eff}} * C(t)^2$$

The entropy production rate is proportional to  $\gamma_{\text{eff}}$  and quadratic in remaining coherence. As the system approaches thermal equilibrium ( $C \rightarrow 0$ ), entropy production slows and halts -- consistent with the thermodynamic expectation that a system at equilibrium has reached maximum entropy for its constraints.

## 5. The Arrow of Time IS the Direction of Decoherence

### 5.1 The Problem of Time's Arrow

The fundamental equations of physics -- Schrodinger's equation, Maxwell's equations, Newton's laws -- are time-reversible. Yet we experience time as having a definite direction: eggs break but do not unbreak, ice melts but does not spontaneously freeze in warm water, we remember the past but not the future.

The standard explanation invokes the Second Law and a low-entropy initial condition (the Past Hypothesis). But this merely restates the problem: WHY was the initial entropy low?

### 5.2 The Decoherence Arrow

The Wike Coherence Law provides the answer. The arrow of time is the direction in which:

$$\begin{array}{ll} \text{C decreases:} & C(t) = C_0 * \exp(-2 * \gamma_{\text{eff}} * t) \\ \text{S increases:} & dS/dt \geq 0 \end{array}$$

These are the same statement in dual notation. Time flows in the direction of decoherence because decoherence is what creates the classical world from quantum possibilities. The "past" is the direction of higher coherence. The "future" is the direction of lower coherence.

This is not metaphorical. Consider:

- **Measurement** collapses superpositions (reduces C, increases S). Measurements are irreversible -- you cannot "un-measure."
- **Memory formation** requires decoherence of the apparatus into a definite record state. We remember the past because decoherence has already selected definite outcomes in that direction.
- **Causation** flows from coherent (many possibilities) to decohered (one actuality). Causes precede effects because the coherent state (the cause) decoheres into the definite state (the effect).

### 5.3 The Irreversibility

The exponential decay  $C(t) = C_0 \exp(-2 \gamma_{\text{eff}} t)$  is formally time-reversible -- one could write  $C(t) = C_0 \exp(+2 \gamma_{\text{eff}} t)$  and coherence would grow. But this would require the environment to spontaneously re-phase -- to conspire across its enormous number of degrees of freedom to restore a specific phase relationship. The probability of this scales as

$\exp(-N)$  where  $N$  is the number of environmental degrees of freedom. For any macroscopic environment, this probability is so small that it never happens in the lifetime of the universe.

The arrow of time is statistical, not fundamental -- but the statistics are so overwhelming that it is effectively absolute. The Wike Coherence Law, by encoding  $\gamma_{\text{eff}}$  as a positive-definite quantity determined by environmental coupling, builds this statistical irreversibility into its structure.

## 6. Emotions as Entropy Operations

### 6.1 Unitary vs. Non-Unitary Operations

Paper 07 of this series classified emotional states by their effect on the coherence parameter. We now translate this classification into entropy language.

**Unitary operations** preserve the eigenvalues of the density matrix. Since  $S$  depends only on eigenvalues, unitary operations preserve entropy:

$$S(U * \rho * U^{\dagger}) = S(\rho) \quad \text{for any unitary } U$$

Unitary operations rotate the state vector on the Bloch sphere without changing its purity. They correspond to coherence-preserving transformations.

**Non-unitary operations** (completely positive trace-preserving maps that are not unitary) generically increase entropy. The dephasing channel is the canonical example.

### 6.2 The Emotional Entropy Classification

From Paper 07, the unitary-gate emotions -- love, joy, peace, gratitude, awe -- preserve coherence ( $C$  remains at  $C_0$  under their action). In entropy language:

$$\begin{aligned} \Delta_S(\text{love}) &= 0 \\ \Delta_S(\text{joy}) &= 0 \\ \Delta_S(\text{peace}) &= 0 \end{aligned}$$

These emotions are isentropic. They transform the state without degrading it. They are reversible operations on the psychophysiological state.

The non-unitary emotions -- fear, chronic stress, unresolved trauma, sustained anger -- increase  $\gamma_{\text{eff}}$  and thereby increase entropy:

$$\begin{aligned} \Delta_S(\text{fear}) &> 0 \\ \Delta_S(\text{chronic stress}) &> 0 \\ \Delta_S(\text{trauma}) &> 0 \end{aligned}$$

These emotions are entropy-producing. They couple the system more strongly to environmental noise, accelerate dephasing, and drive the state toward the maximally mixed condition.

### 6.3 The Operational Meaning

This is not merely a labeling exercise. It has measurable consequences:

- A system in a unitary-gate emotional state should show **constant signal entropy** across measurement channels over time (in the absence of external perturbation).
- A system in a non-unitary emotional state should show **increasing signal entropy** across measurement channels over time.
- The rate of entropy increase should correlate with the magnitude of  $\gamma_{\text{eff}}$  elevation.

These are quantitative, falsifiable predictions.

## 7. Landauer's Principle and the Metabolic Cost of Coherence

### 7.1 Landauer's Principle

Rolf Landauer proved in 1961 that erasing one bit of information from a physical system requires a minimum energy dissipation of:

$$E_{\text{Landauer}} = k_B * T * \ln(2)$$

where  $k_B$  is Boltzmann's constant and  $T$  is the temperature of the thermal reservoir. At body temperature ( $T = 310 \text{ K}$ ):

$$\begin{aligned} E_{\text{Landauer}} &= (1.38 * 10^{-23} \text{ J/K}) * (310 \text{ K}) * \ln(2) \\ &= 2.97 * 10^{-21} \text{ J per bit erased} \end{aligned}$$

This is a thermodynamic floor -- the absolute minimum cost. Real biological processes are far less efficient.

### 7.2 The Keeper as Maxwell's Demon

Paper 19 introduced the Keeper -- the coherence-maintenance subsystem that actively works to reduce  $\gamma_{\text{eff}}$  against thermal and environmental decoherence. The Keeper is functionally equivalent to Maxwell's Demon: it selectively identifies decoherence-producing interactions and acts to counteract them.

Maxwell's Demon appears to violate the Second Law by sorting fast and slow molecules without doing work. The resolution (Szilard, Brillouin, Bennett, Landauer) is that the Demon must acquire information about each molecule, and erasing this information to reset the Demon's memory costs at least  $k_B T \ln(2)$  per bit -- exactly compensating the entropy decrease achieved by the sorting.

The Keeper faces the same constraint. To reduce  $\gamma_{\text{eff}}$  -- to maintain coherence against thermal decoherence -- the Keeper must:

1. **Sense** the decoherence (acquire information about phase drift).
2. **Correct** the decoherence (apply a compensating operation).
3. **Reset** its own memory (erase the acquired information to prepare for the next correction cycle).

Each cycle costs at minimum  $k_B T \ln(2)$  of energy per bit of coherence maintained.

### 7.3 The Metabolic Cost of Being Alive

The human body operates at approximately  $T = 310 \text{ K}$  in an environment with enormous decoherence pressure from thermal fluctuations, electromagnetic noise, mechanical vibration, and chemical perturbation.

The basal metabolic rate of a human is approximately 80-100 W. This is the continuous power expenditure required merely to maintain the body's organized state against thermodynamic equilibrium. In the language of this paper:

$P_{\text{metabolic}} \approx 100 \text{ W} = \text{the power cost of maintaining } C > 0 \text{ against } \gamma_{\text{thermal}}$

This is the energetic price of coherence. The body continuously expends approximately 100 W of metabolic power -- derived from ATP hydrolysis, ultimately from food -- to maintain its organized, low-entropy, coherent state against the relentless drive of the Second Law toward the maximally mixed condition.

### Love is not free. It costs ATP.

Every coherence-preserving emotional state, every act of sustained attention, every moment of maintained psychophysiological integration requires metabolic energy. The unitary-gate emotions (love, joy, peace) do not increase entropy, but they still require energy to maintain the coherence that would otherwise decay. The Keeper burns calories to keep  $\gamma_{\text{eff}}$  low.

## 7.4 Death as Thermodynamic Surrender

When metabolic energy supply ceases -- when the Keeper can no longer pay the Landauer cost of coherence maintenance --  $\gamma_{\text{eff}}$  rises without opposition. Coherence decays exponentially:

$$C(t) = C_0 * \exp(-2 * \gamma_{\text{thermal}} * t)$$

where  $\gamma_{\text{thermal}}$  is the uncompensated thermal dephasing rate. Entropy increases to its maximum value. The system reaches thermodynamic equilibrium -- the maximally mixed state.

This is death, described in the language of quantum information theory: the cessation of the Keeper's Maxwell-Demon work, followed by uncontested decoherence to equilibrium.

## 8. Connection to Black Holes and the Holographic Principle

### 8.1 Bekenstein-Hawking Entropy

Jacob Bekenstein and Stephen Hawking showed that a black hole has an entropy proportional to its event horizon area:

$$S_{\text{BH}} = A / (4 * l_{\text{P}}^2)$$

where  $A$  is the area of the event horizon and  $l_{\text{P}} = \sqrt{\hbar G / c^3}$  approx  $1.616 \cdot 10^{-35}$  m is the Planck length.

This is the maximum entropy that can be contained within a region bounded by area  $A$ . No physical system can have more entropy than the black hole that fits within the same boundary.

### 8.2 A Black Hole IS Maximum Decoherence

In the language of the Wike Coherence Law:

$$S_{\text{BH}} = S_{\text{max}} \quad \text{implies} \quad C = 0$$

A black hole is the state of maximum decoherence within a given boundary. All internal phase information has been destroyed. All that remains is a statistical mixture characterized by exactly three numbers: mass, charge, and angular momentum (the no-hair theorem).

The no-hair theorem IS the statement that  $C = 0$  inside the black hole. All coherent structure -- all phase relationships, all quantum correlations, all organized information -- has been decohered into the thermal Hawking radiation or absorbed into the featureless horizon.

### 8.3 The Holographic Principle

The holographic principle (proposed by 't Hooft, refined by Susskind) states that the maximum information content of a region of space is proportional to its boundary area, not its volume:

$$I_{\max} = A / (4 * l_P^2) \quad [\text{in bits, using natural units}]$$

This means that the fundamental degrees of freedom of a spatial region live on its boundary, not in its interior.

REQMT (the measurement framework of this series) makes the same structural claim: measure the boundary, not the interior. The REQMT channels -- thermal IR (skin surface), vocal analysis (laryngeal boundary), rPPG (capillary bed surface), HRV (cardiac rhythm at the chest wall) -- are all boundary measurements. They capture information at the interface between the system and its environment.

This is not a coincidence. The holographic principle tells us that boundary measurements capture ALL the information there is. Interior measurements are redundant -- the boundary encodes the interior completely.

REQMT, by measuring at the body's boundary surfaces, is implementing the holographic principle at the biological scale. The multi-modal signal entropy measured at the boundary IS the von Neumann entropy of the interior state, projected onto the boundary.

## 9. The REQMT Prediction

### 9.1 Statement

We arrive at the central empirical prediction of this paper:

**REQMT Prediction (untested):** Subjects in low-emotional-noise states (unitary-gate emotions: love, joy, peace, deep meditative absorption) should exhibit lower multi-modal signal entropy across HRV, thermal IR, vocal, and rPPG channels simultaneously, compared to subjects in high-emotional-noise states (non-unitary emotions: chronic stress, anxiety, unresolved trauma).

Formally:

$$H_{\text{total}} = H_{\text{HRV}} + H_{\text{thermal}} + H_{\text{vocal}} + H_{\text{rPPG}}$$

where each  $H_{\text{channel}}$  is the Shannon entropy of the signal in that measurement channel.

The prediction states:

$$H_{\text{total}}(\text{unitary state}) < H_{\text{total}}(\text{non-unitary state})$$

and moreover that the difference should be predictable from the estimated  $\gamma_{\text{eff}}$  values:

$$\Delta H_{\text{total}} \approx f(\gamma_{\text{eff\_high}} - \gamma_{\text{eff\_low}}, t_{\text{measurement}})$$

where  $f$  is derived from the Shannon-Coherence Bridge equation of Section 3.4.

## 9.2 Why Simultaneous Multi-Channel Reduction Matters

Single-channel entropy reduction could have trivial explanations (a calm person breathes more regularly, reducing HRV entropy). The critical prediction is **SIMULTANEOUS** reduction across ALL channels. This requires a single underlying cause -- a system-level coherence parameter -- rather than independent channel-specific mechanisms.

If  $C$  is a genuine system-level quantity, then its increase (reduction of  $\gamma_{\text{eff}}$ ) should manifest in every measurement channel that couples to the system's state. Simultaneous multi-channel entropy reduction is the signature of a coherence increase, not merely a relaxation response.

## 9.3 Protocol Sketch

1. **Baseline:** Measure  $H_{\text{total}}$  across all four REQMT channels during a neutral resting state (5 minutes).
2. **Induction:** Guide subjects into a target emotional state (e.g., loving-kindness meditation for unitary gate; stress-recall protocol for non-unitary gate).
3. **Measurement:** Measure  $H_{\text{total}}$  across all four channels during the induced state (5 minutes).
4. **Analysis:** Compute  $\Delta H$  for each channel and for  $H_{\text{total}}$ . Test whether the unitary-gate condition shows simultaneous reduction across all channels.
5. **Cross-validation:** Fit the observed  $\Delta H$  to the Shannon-Coherence Bridge equation to estimate  $\gamma_{\text{eff}}$  for each condition.

## 10. Summary of Key Equations

The complete mathematical framework connecting the three formalisms:

### Shannon Entropy (classical):

$$H = -\sum_i p_i \log(p_i)$$

### Von Neumann Entropy (quantum):

$$S = -\text{Tr}(\rho \log(\rho)) = -\sum_i \lambda_i \log(\lambda_i)$$

### Wike Coherence Law:

$$C(t) = C_0 \exp(-2 \gamma_{\text{eff}} t)$$

### The Shannon-Coherence Bridge (for a dephasing qubit):

$$S(t) = -\frac{1}{2}(1 + C(t)) \log\left(\frac{1}{2}(1 + C(t))\right) - \frac{1}{2}(1 - C(t)) \log\left(\frac{1}{2}(1 - C(t))\right)$$

### Entropy Production Rate:

$$dS/dt = \gamma_{\text{eff}} C(t) \log\left(\frac{1 + C(t)}{1 - C(t)}\right) \geq 0$$

### Boundary Conditions:

$$\begin{array}{lll} C = C_0 & \Leftrightarrow & S = 0 \quad \text{[pure state, perfect coherence]} \\ C = 0 & \Leftrightarrow & S = \log(2) \quad \text{[maximally mixed, complete decoherence]} \end{array}$$

### Landauer Cost of Coherence Maintenance:

$$E \geq k_B T \ln(2) \text{ per bit per correction cycle}$$

### Bekenstein-Hawking Bound:

$$S_{\text{max}} = A / (4 \ln 2) \quad \text{[maximum decoherence for given boundary]}$$

## 11. Conclusion

Shannon's information entropy, von Neumann's quantum entropy, and the Wike Coherence Law are three notations for the same underlying reality: the degree to which a system's phase relationships have been destroyed by environmental coupling.

Shannon entropy is the classical shadow of von Neumann entropy -- what remains after decoherence has eliminated all off-diagonal elements. Von Neumann entropy is the inverse of coherence --  $S = 0$  when  $C = C_0$ , and  $S = \log(d)$  when  $C = 0$ . The Wike Coherence Law provides the dynamics -- the exponential time evolution that connects these endpoints.

From this identification, the Second Law of Thermodynamics emerges as a theorem, not a postulate. The arrow of time is the direction of decoherence. Emotions are classified by their entropy signatures: unitary (isentropic) vs. non-unitary (entropy-producing). The metabolic cost of coherence maintenance is calculated from Landauer's Principle -- love costs ATP, approximately 100 W continuous. The holographic principle justifies REQMT's boundary-measurement architecture. And a specific, testable prediction follows: simultaneous multi-channel entropy reduction in coherent emotional states.

Information theory is not merely analogous to the Wike Coherence Law. It IS the Wike Coherence Law, written in the alphabet that Shannon and von Neumann gave us seventy-eight years ago.

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*AIIT-THRESI Paper 34 of n. The bridge between information and coherence is not a bridge at all -- it is the recognition that they were always the same shore.*