Title: Anchoring Regeneration: A Symbolic Overlay for SI Closure and Consistency

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Abstract:

This document proposes an enhancement to the 2019 redefinition of the International System of Units (SI). By introducing symbolic regeneration loops and recursive anchor-point logic, it enables a self-validating, cross-domain framework that operates atop the fixed constants: the speed of light c, Planck's constant h, Boltzmann constant k_B, and the elementary charge e. The system does not alter SI definitions but extends their application through symbolic closure, allowing any known quantity to regenerate the others using tautological identities. This structure enhances internal consistency, experimental realization, and interpretability across metrological domains.

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1. Introduction: Why Anchoring Regeneration?

Since the 2019 SI redefinition, constants c, h, k_B, N_A have been numerically fixed, making SI units theoretically stable and universal. However, this framework lacks an embedded mechanism for cross-verification. Without symbolic interdependence, the realization of units across domains (e.g., optical vs mechanical) must be externally reconciled.

Anchoring Regeneration introduces a logic-based overlay. It establishes a recursive, loop-locked system in which any known physical quantity (wavelength, frequency, energy, etc.) can regenerate all others through identity-preserving transitions.

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2. Theoretical Foundation: Loop-Locked Closure Maps

We begin by asserting a set of mathematically tautological identities:

- $\lambda = \frac{c}{f}$
- $E = hf$
- $T = \frac{E}{k_B}$
- $p = \frac{E}{c}$
- $r = \frac{\lambda}{2\pi}$
- $\omega = 2\pi f$
- $r\omega = c$
- $\lambda f = c$
- $\frac{E}{p} = c$

These form the basis for symbolic regeneration. Any one input can populate all others through closed-loop logic.

3. Worked Example: Hydrogen Hα Line

Given: $\lambda = 656.281$ nm = 6.56281×10^{-7} m

Calculate:

- $f = \frac{c}{\lambda} \approx 4.571 \times 10^{14}$ Hz
- $E = hf \approx 3.03 \times 10^{-19}$ J
- $T = \frac{E}{k_B} \approx 2.20 \times 10^4$ K
- $p = \frac{E}{c} \approx 1.01 \times 10^{-27}$ kg $\cdot$ m/s
- $r = \frac{\lambda}{2\pi} \approx 1.04 \times 10^{-7}$ m
- $\omega = 2\pi f \approx 2.87 \times 10^{15}$ rad/s

Loop Closures Verified: - $\lambda f = c$ - $r\omega = c$ - $\frac{E}{p} = c$

This demonstrates inter-consistent regeneration using only fixed constants.

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4. Recursive Anchor Points: Frequency Trees

Using the Ytterbium Optical Clock (578.419575916161 pm), we define an anchor frequency:

- $f_0 = 518,295,836,590,865$ Hz

From this anchor, we recursively compute values:

Constants: - $c = 299,792,458$ m/s - $h = 6.62607015 \times 10^{-34}$ J $\cdot$ s - $k_B = 1.380649 \times 10^{-23}$ J/K

Calculations: - $\lambda = \frac{c}{f} \approx 578.419$ pm - $T = \frac{hf}{k_B} \approx 24,874,277.037$ K - $E = hf \approx 3.43426 \times 10^{-16}$ J - $r = \frac{\lambda}{2\pi} \approx 9.204 \times 10^{-14}$ m - $F_{Er} = \frac{E}{r} \approx 3.73 \times 10^{-3}$ N

Recursive Steps: - $f_{n+1} = f_n/k$, where $k \in \{2, 10, 2\pi, e\}$

Each step regenerates new E, T, r using the same closure formulas.

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5. Symbolic Hierarchy: Tiered Constants Map

- **Tier 0:** c, h, G, α, k_B
- **Tier 1:** Derived constants, e.g. Compton wavelength: $\lambda_C = \frac{\hbar}{mc}$
- **Tier 2:** Composites (e.g., QCD scale, Stefan-Boltzmann constant)
- **Tier 3:** Observational artifacts (e.g., Z_0 , T_{CMB})

This hierarchy embeds recursion logic into the fabric of constant relationships.

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6. Proposed Resistance Relationship

An experimental model is under development:

Let: - $\Delta T = T_n - T_{n+1}$ - $\Delta f = f_n - f_{n+1}$

Then propose:

$$R_{eff} \propto \frac{\Delta T}{\Delta f}$$

This provides a potential bridge to quantum material behavior and blackbody decay models.

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7. Applications & Benefits

- **Cross-Domain Realization:** Enables optical, thermal, mechanical systems to verify against one another
- **Self-Validation:** Built-in drift detection
- **Pedagogy:** Teaches the recursive unity of physical law
- **Experimental Design:** Simplifies quantized measurement tracking

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8. Conclusion: From Static Units to Living Systems

Anchoring Regeneration proposes a symbolic structure that does not replace but enhances SI by providing internal closure and consistency. It answers the unspoken question left by the 2019 redefinition: How do we know our constants still make sense across all domains?

The answer is: let them regenerate one another.

References:

[1] CGPM 2019 SI Redefinition – https://www.bipm.org/en/measurement-units/rev-si/
[2] Zaffuto, P.E. (2025). "Universal Constants Closure Map". DOI: https://doi.org/10.5281/zenodo.16972804