Phase F Developer Reference Sheet: Chamber XX — Recursive Tensor Potentials and the τ-Field Bridge

UNNS Research Collective
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PURPOSE

This reference sheet condenses the theoretical foundations of the paper *"Recursive Tensor Potentials and the τ-Field Bridge"* into implementation-ready guidance for developers building the Chamber XX simulation engine under Phase F.

CORE DEFINITIONS

$$R_{ij} = O_i(\tau_i) - O_j(\tau_j) \quad \text{(operator-differential recursion tensor)}, \tag{1}$$

$$R'_{ij} = O_i(\tau_j) - O_j(\tau_i) \quad \text{(optional cross-field extension)}, \tag{2}$$

$$R_{ij} = -R_{ji} \quad \text{(antisymmetry condition)}, \tag{3}$$

$$\mathcal{E} = \tfrac{1}{2} \sum_{i<j} \|R_{ij}\|^2 \quad \text{(recursion energy density)}. \tag{4}$$

DISCRETE OPERATORS (2-D)

For grid spacings Δx, Δy:

$$\Phi(x,y) = \frac{R_{ij}(x+\Delta x, y) - R_{ij}(x-\Delta x, y)}{2\Delta x} + \frac{R_{ij}(x, y+\Delta y) - R_{ij}(x, y-\Delta y)}{2\Delta y}, \tag{5}$$

$$\Psi(x,y) = \frac{R_{ij}(x, y+\Delta y) - R_{ij}(x, y-\Delta y)}{2\Delta y} - \frac{R_{ij}(x+\Delta x, y) - R_{ij}(x-\Delta x, y)}{2\Delta x}. \tag{6}$$

Φ is the divergence field (scalar potential), Ψ the curl field (rotational potential).

COUPLING FRAMEWORK

$$\tau'_k = \tau_k + \sum_l \alpha_{kl}\, \rho(R_l), \tag{7}$$

$$\rho(R_l) = \sqrt{\frac{1}{N} \sum_{x,y} R_l^2(x,y)}, \tag{8}$$

$$\rho(\alpha) < 1 \quad \text{for stability.} \tag{9}$$

Each α_{kl} controls feedback strength between recursion fields.

VALIDATION METRICS

Antisymmetry error	$\lvert R_{ij} + R_{ji} \rvert$	< 0.005
Orthogonality	$\lvert \langle E \cdot B \rangle \rvert$	$< 10^{-3}$
Equilibrium slope	$\lvert \nabla \mathcal{E} \rvert$	$< 10^{-6}$
Spectral radius	$\rho(\alpha)$	< 1.0

PERFORMANCE TARGETS

- Grid resolution: 512^2
- Frame rate: ≥ 60 fps
- CPU load: $\leq 70\%$
- Laplacian caching and ImageData rendering inherited from Chamber XIX v19.1.2 (CORRECTED)

JSON SCHEMA VF.0.1

```
{
  "phase": "F",
  "chamber": "XX",
  "grid": 512,
  "fields": 3,
  "timestamp": "...",
  "seed": 41,
  "Rij_energy": 0.0,
  "operator_modes": ["Interlace","-Scale","Prism","Fold"]
}
```

MODULE CHECKLIST

1. **phaseF_bridge.js**
   - computeDivergence(Rij, grid)
   - computeCurl(Rij, grid)
   - normalizeField(), exportTensorObject()
2. **phaseF_validator.js**
   - validateAntisymmetry(), validateConservation()
   - validateOrthogonality(), validateEquilibrium()
3. **json_exporter.js**
   - Include full schema, timestamp, and seed

IMPLEMENTATION BASELINE

Use Chamber XIX v19.1.2-CORRECTED engine as baseline. Retain Laplacian caching, async pause/resume, and performance profiling modules.

PHASE F GOAL

To construct and validate the τ-Field Bridge that connects recursive tensor potentials into a self-consistent, Maxwell-analog framework—establishing the mathematical and computational foundation for unified recursive field equations in Phase F.