FRACTAL-WAVE ALGEBRA

DYNAMICS: FROM INFORMATION TO A SELF-GENERATING WAVE STRUCTURE

1. FIELD DYNAMICS AND RECURSIVE CLOSURE

The ontology introduced in the preceding pages becomes physical only when the relations between its elements are made dynamical. FWA therefore does not treat Φ as a static field. Φ is a state of an evolving process, and its successive states are generated by an operator acting on the structure already present.

Let $\Phi_n(r,t)$ denote the wave state at recursion level n. The fundamental FWA transformation is:

$$\Phi_{n+1} = F\left(\Phi_n, \nabla\Phi_n, \partial\Phi_n / \partial t, T_n\right)$$

Here F is not assumed to be a linear superposition operator. It may transform amplitude, phase, scale, orientation and topology simultaneously. T_n denotes the local transformation conditions acting at level n. The defining requirement is recursive closure: the next structure is generated from the current structure rather than imposed independently.

2. SELF-SIMILARITY AND SCALE

A fractal-wave state can reproduce its organization across scales while changing its local phase and amplitude. A minimal representation is:

$$\Phi_{n+1}(r, t) \approx A_n \Phi_n\left(\lambda_r r, \lambda_t t + \delta_n\right)$$

The parameters A_n, λ_r, λ_t, and δ_n describe amplitude, spatial scale, temporal scale and phase displacement. Fractality therefore means more than geometric repetition: the same generative rule can act at multiple scales while preserving a family of invariants.

The important point is that scale is not an external coordinate imposed on the structure. Scale becomes part of the recursive state itself. A structure at one level can therefore become the generator of the next level.

3. Lu AS THE MINIMAL DIFFERENTIATION

The transition from ideal symmetry to a realized state requires a nonzero difference. FWA denotes this minimal differentiation by Lu.

If $S[\Phi]$ represents the symmetry functional of a state and S_* its ideal reference state, then the local differentiation can be represented schematically as:

$$Lu \propto \left| S[\Phi] - S_* \right|$$

with

$$Lu \to 0 \quad \Rightarrow \quad \textit{idealized symmetry}$$

Lu is not identified with an ordinary particle or conventional field. It represents the structural gap between an ideal symmetric configuration and its realized state.

At the limiting transition, the dynamic zero 0' represents the point at which differentiation becomes capable of initiating a new wave cycle. Thus the zero is not treated as simple absence. It is a dynamical boundary between states.

$$S_* \to Lu \to 0' \to \Phi \to \Phi'$$

The resulting process is recursive rather than linear: realization generates a new state, and the new state becomes the input for the next transformation.

4. CONTINUUM DYNAMICS

At the continuum level, one possible minimal realization of the recursive principle is:

$$\partial\Phi / \partial t = A\, \nabla^2\Phi - V'(\Phi) + C\, \Omega\, \Phi$$

where the structural deviation may be represented by:

$$\Omega = |\nabla\Phi|^2 - |\nabla\Phi_{sym}|^2$$

The first term describes spatial propagation or diffusion of the wave state. The potential term determines local nonlinear evolution. The Ω-term introduces feedback associated with departure from the symmetric reference configuration.

The equation should therefore be understood as a dynamical realization of the ontology rather than as an established physical law. Its physical status depends on derivation, dimensional consistency, boundary conditions, conservation laws and experimental comparison.

The central FWA question is not simply whether a wave exists, but whether the wave can generate and stabilize its own hierarchy of states.

A stable configuration can therefore be represented as:

$$F(\Phi_n) \to \Phi_{n+1} \to \Phi_{n+2} \to \ldots$$

while an attractor corresponds to a class of states satisfying:

$$F(\Phi_*) \approx \Phi_*$$

or, for a periodic structure,

$$F^{k}(\Phi_{*}) \approx \Phi_{*} \quad \textit{for some finite } k$$

This provides a mathematical route from recursion to stable structures.

5. OBSERVABLE REALITY AND CORE PRINCIPLE

The observable is not identified directly with the generating information. Observation is a projection of the recursively generated structure:

$$O = M\,[\,R\,(\,F\,(\,I, S, 0', \Phi\,)\,)\,]$$

Here F represents generation, R the realized wave organization, and M the measurement map. This separation is important. The internal generating state and the measured state are not necessarily identical.

Consequently, $\Phi_a \neq \Phi_b$ may still produce $M[R(\Phi_a)] = M[R(\Phi_b)]$. Conversely, a small structural change in the generating state may produce a large change in the observable when the system crosses a stability boundary.

The observable world is therefore treated as the projection of an underlying recursive dynamics, rather than as the complete description of that dynamics.

FWA defines reality as an evolving hierarchy of wave states rather than as a collection of primitive static objects. The complete generative chain is:

$$I \rightarrow S \rightarrow Lu \rightarrow 0' \rightarrow \Phi \rightarrow F(\Phi) \rightarrow R \rightarrow O$$