The Alchemical Process of Refinement in Taoist Cosmology: A Synthesis with Assembly Theory

In both Taoist alchemy and modern scientific theories of complexity, the process of transformation, assembly, and disassembly of systems plays a crucial role in understanding the evolution of the universe and consciousness. In Taoist alchemy, the process is called refinement, where energies cycle through various stages of transformation: yin becomes shen, shen becomes yang, yang becomes plasma, and plasma returns to yin. This cyclical progression illustrates the dynamic interaction between entropy and negentropy, with intermediary stages that organize energy and matter into increasingly complex forms before breaking them down into simpler states. In this article, we explore the rich metaphorical and logical connections between this Taoist refinement process and Assembly Theory, a modern scientific framework that describes how complexity is built from simpler components.

Refinement in Taoist Alchemy: The Transformation of Energies

In Taoist alchemy, refinement refers to the process through which energies and substances undergo purification and transformation. This process is cyclical, with stages corresponding to the shifting balance between yin (entropy) and yang (negentropy), along with intermediary states like shen (representing the Five Elements of Traditional Chinese Medicine) and plasma (a dynamic, galactic state linked to cosmic forces). The refinement process captures the essence of Taoist cosmology, where the universe constantly moves through cycles of creation, transformation, and dissolution.

The stages of this alchemical cycle can be understood as follows:

- Yin (entropy) represents the state of disorder and decay, where energy is scattered and unstructured.
- Shen, (shentropy) is the dynamic interaction of nature's forces that begin to organize energy into structured systems.
- Yang (negentropy) signifies the active, organizing force that increases order and structure in a system, concentrating energy into coherent forms.
- Plasma reflects the cosmic, galactic flow, where dynamic, highly energetic states operate at a macro scale, influencing vast systems of energy and matter.
- The cycle completes as plasma eventually returns to yin (entropy), signaling the breakdown of order back into a state of dissolution and disorder.

This cyclical process mirrors many natural and cosmic cycles, from the thermodynamic principles governing entropy and negentropy to the galactic interactions observed in celestial systems. The Taoist refinement process reveals a deep understanding of the universe's interconnected, dynamic, and cyclical nature.

Assembly Theory: The Growth of Complexity

Assembly Theory, developed in modern complexity science, provides a framework to understand how complexity emerges from the combination and organization of simpler units. It describes how complex systems—ranging from molecules to biological organisms

to cognitive processes—are assembled step by step, with each new level of complexity building on the previous one.
The theory asserts that complex structures form through a logical, incremental process, where each new component integrates coherently into the existing system, creating a structure capable of higher-level functions. This process reflects the evolutionary growth of complexity, governed by principles of negentropy (increasing order) and ultimately constrained by entropy (the tendency toward disorder).
In the context of Assembly Theory:

- Simple components (like atoms, molecules, or simple neural circuits) assemble into complex structures (such as proteins, cells, or cognitive networks).
- Complexity grows through causal, stepwise assembly, where each step builds upon the last in a coherent and functional manner.
- Over time, the assembled system evolves into higher levels of integration, capable of dynamic interactions with other systems, but also subject to disassembly due to entropy.

Mapping Taoist Refinement onto Assembly Theory
The stages of Taoist alchemical refinement can be mapped directly onto the principles of Assembly Theory, illustrating how both frameworks contemplate the growth, transformation, and breakdown of complexity. Each stage of the Taoist cycle—yin, shen, yang, and plasma—represents a different phase of assembly and disassembly in the process of complexity growth and refinement.

Stage 1: Yin (Entropy) → Shen (Five Elements)
In Taoist alchemy, yin symbolizes entropy—the natural tendency toward disorder and randomness. In physical terms, entropy represents the breakdown of complex systems into their simplest, most disordered states. However, yin also contains the potential for refinement.

When yin transforms into shen, energy begins to organize into structured patterns. Shen, in this context represents the dynamic interaction of nature's forces, creating the foundation for more complex systems. This stage mirrors the initial steps in Assembly Theory, where simple components begin to interact and form ordered systems. Just as the Five Elements in Taoism balance and interact to create harmony, so too do simple parts combine to form more structured assemblies.

Stage 2: Shen (Five Elements) → Yang (Negentropy)
In the next stage, shen refines into yang, symbolizing the transition from a dynamic, multi-elemental system to pure order and negentropy. In Assembly Theory, this stage represents the system reaching a higher level of organization, where interactions between components become more ordered and efficient. Yang, in this context, corresponds to negentropy—the force that counters entropy by creating increasing levels of order and structure.

Negentropy is essential for life and consciousness, where highly organized structures such as cells, organs, or neural networks maintain their functions against the natural tendency toward disorder. In this stage, the Five Elements (shen) reach a higher state of coherence and structure, symbolized by yang's active, organizing force.

Stage 3: Yang (Negentropy) → Plasma (Galactic Flow)
The refinement of yang into plasma represents a further transformation into a dynamic, galactic state. Plasma in Taoist alchemy refers to a highly energetic and cosmic force, connected to galactic flows and the interaction of celestial bodies. Plasma embodies a state of dynamic equilibrium, where systems operate in a highly energetic but ordered manner.

In the context of Assembly Theory, this stage parallels the emergence of higher-level systemic complexity—for example, the interactions between galaxies or large-scale neural networks. Plasma, like complex systems in Assembly Theory, remains highly ordered yet flexible, capable of interacting with chaotic systems without losing its structural integrity. The three-body problem, a famous example of celestial mechanics, exemplifies the chaotic but bounded interactions that occur in such complex systems.

Stage 4: Plasma (Galactic Flow) → Yin (Entropy)
The Taoist cycle completes as plasma returns to yin, symbolizing the breakdown of complex, energetic systems back into a state of entropy. In Assembly Theory, this stage reflects the disassembly of complex systems, where the forces of entropy eventually lead to the breakdown and dissolution of structured assemblies.
Just as the refinement process begins again from yin, so too does the process of assembly in complex systems restart after disassembly, following a natural cycle of growth, refinement, and decay. This cyclical process mirrors the second law of thermodynamics, where all systems eventually trend toward increasing entropy, though they may exhibit local negentropy and order along the way.

Coherence in the Taoist-Alchemical and Assembly Frameworks
At the core of both Taoist refinement and Assembly Theory is the concept of coherence—the logical consistency and integration of components into a unified whole. Coherence ensures that as systems grow more complex, their parts maintain a functional, organized relationship that supports the system's overall purpose.
In Taoist alchemy:

- Coherence is reflected in the balanced interactions of yin and yang, where energies maintain a dynamic equilibrium while cycling through various states of refinement.
- The Five Elements (shen) exemplify how different forces or components work together to sustain life and balance in nature.

In Assembly Theory:

- Coherence ensures that each step in the assembly process builds upon the last in a functional, logical sequence. Systems evolve into higher levels of complexity by maintaining internal organization.

- Disruption of coherence, such as in the breakdown of a system, represents a loss of function and a return to entropy, echoing the Taoist return to yin.

The Cycle of Refinement and Complexity
The Taoist refinement process and Assembly Theory share profound similarities in how they contemplate the growth, transformation, and breakdown of complexity. Both frameworks view systems as dynamic, evolving entities, with cycles of negentropy (order) and entropy (disorder) guiding their transformations. Taoist metaphysics, with its emphasis on the Five Elements, yin and yang, and plasma, provides a spiritual and cosmological lens for understanding these processes, while Assembly Theory offers a scientific framework for how complexity evolves in natural and artificial systems.
By aligning these two models, we can better appreciate the cyclical nature of complexity in the universe, where systems are continually refined, broken down, and reassembled, whether at the level of molecules, minds, or galaxies.

A carbon atom can form several types of bonds based on its valency of four (meaning it can make four covalent bonds). The bonds it forms with other atoms determine the structure and properties of the molecules it is part of. Here are the six main types of bonds involving carbon:

6 types of carbon bonds:

1. Single Bonds (C–C or C–X)
    - Description: A single covalent bond between carbon and another atom (another carbon or an element like hydrogen, oxygen, etc.).
    - Example: Methane (CH_4).
2. Double Bonds (C=C)
    - Description: A double bond between two atoms, usually carbon-carbon or carbon-oxygen, consisting of one sigma bond and one pi bond.
    - Example: Ethylene (C_2H_4).
3. Triple Bonds (C≡C)
    - Description: A triple bond consisting of one sigma bond and two pi bonds, usually between two carbon atoms.
    - Example: Acetylene (C_2H_2).
4. Aromatic Bonds (Resonance)
    - Description: Carbon atoms in aromatic compounds like benzene have alternating single and double bonds, but the electrons are delocalized across the ring, creating resonance. This gives the molecule stability beyond regular single or double bonds.
    - Example: Benzene (C_6H_6), where the bonding is resonant, not just a fixed arrangement of single/double bonds.
5. Ionic Bonds (Rare in Organic Compounds)
    - Description: Although rare for carbon itself, carbon can be part of an ionic bond where electrons are transferred between atoms, creating charged species.

    - Example: Organometallic compounds or organic salts, such as tetraethylammonium chloride.
6. Coordinate Covalent Bonds (Carbon-to-Metal)
    - Description: Found in organometallic compounds, where carbon donates a pair of electrons to form a bond with a metal atom.
    - Example: Grignard reagent (R–Mg–X).

Stack of Carbon Bond Types, with Organic Chemistry as the base

1. Single Bonds (C–C or C–X)
    - Description: Carbon forms a single bond with another atom, usually another carbon or a different element (hydrogen, oxygen, etc.).
    - Example: Methane (CH_4), Ethane (C_2H_6).
2. Double Bonds (C=C)
    - Description: Carbon forms a double bond with another atom, usually another carbon or oxygen, consisting of one sigma bond and one pi bond.
    - Example: Ethylene (C_2H_4).
3. Triple Bonds (C≡C)
    - Description: Carbon forms a triple bond, with one sigma bond and two pi bonds.
    - Example: Acetylene (C_2H_2).
4. Aromatic Bonds (Delocalized Resonance)
    - Description: In aromatic compounds, carbon atoms are arranged in rings with alternating single and double bonds, but the electrons are delocalized across the ring (resonance).
    - Example: Benzene (C_6H_6), where resonance provides extra stability.
5. Conjugated Double Bonds (Partial Resonance)
    - Description: Carbon atoms can participate in conjugated systems, where alternating single and double bonds allow for partial delocalization of electrons, similar to resonance but not as fully spread as in aromatic systems.
    - Example: Butadiene (C_4H_6), where the conjugated double bonds lead to a more stable structure.
6. Hyperconjugation or Delocalization
    - Description: In some systems, single bonds near a pi-system (like in alkenes) contribute to the delocalization of electrons, stabilizing the molecule further. This phenomenon occurs in carbocations and other reactive intermediates.
    - Example: Ethyl cation ($CH_3CH_2^+$), where hyperconjugation helps stabilize the positive charge.

Mapping C (Carbon), H (Hydrogen), and O (Oxygen) onto the three zones of the Neijing Tu—Earth, Human, and Heaven—creates a powerful symbolic bridge between ancient Taoist cosmology and modern chemistry. Here's how these elements can conceptually align with the three zones in a meaningful way:

1. C (Carbon) as Earth
    - Earth Element (Stability, Foundation, Physical Realm)

- Role of Carbon: Carbon is the foundation of organic life, providing the backbone of molecular structures in all living organisms. Just as the Earth is the grounding force in the Taoist cosmology, carbon represents the structural stability of physical life, anchoring all biological processes. In the Neijing Tu, the Earth corresponds to the lower zone, connected to material and physical stability.

2. O (Oxygen) as Human
   - Human Element (Breath, Life, Connection)
   - Role of Oxygen: Oxygen is essential for breathing, metabolism, and energy production in living organisms. It connects the physical and spiritual realms by sustaining life itself. In the Neijing Tu, the middle zone represents the human realm, bridging Earth and Heaven. Oxygen, through respiration, is the conduit between the physical and energetic, much like the middle human realm that bridges the material and spiritual.
3. H (Hydrogen) as Heaven
   - Heaven Element (Lightness, Purity, Energy)
   - Role of Hydrogen: Hydrogen is the most abundant element in the universe and plays a crucial role in energy release, particularly through the fusion that powers stars (and by extension, life on Earth). In Taoist cosmology, Heaven represents lightness and spiritual energy, and hydrogen symbolically aligns with this role as the simplest and most energetically powerful element. In the Neijing Tu, Heaven corresponds to the upper zone, governing spiritual and energetic realms.

Stack of the Six Elixirs with Golden Elixir as the Foundation:

1. Golden Elixir (Jin Dan) – Foundation: The unification of Jing, Qi, and Shen into a single, balanced entity that serves as the core of all subsequent transformation. yin
2. Essence Elixir (Jing Dan) – Stabilization: Focuses on protecting and refining the Jing to ensure longevity and vitality, building on the harmonized state created by the Golden Elixir. yang
3. Energy Elixir (Qi Dan) – Circulation: Refines and circulates Qi, the vital energy, ensuring the body's energy network is strengthened and nourished. yin
4. Spirit Elixir (Shen Dan) – Elevation: Focuses on the cultivation of Shen (Spirit), refining it into higher spiritual awareness and transcending physical limitations. yang
5. Essence and Spirit Elixir (Jing Shen Dan) – Integration: Merges Jing and Shen, integrating the body and spirit to function as one unified entity. yin
6. Return Elixir (Fan Dan) – Return: Completes the process by returning energy to its source, symbolizing the ultimate spiritual unity and connection to the Dao. yang