

Yin Yang Cosmology

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Abstract

Inspired by Niels Bohr's adoption of the Taijitu symbol of Yin Yang in his quantum complementarity worldview, this original paper introduces Yin Yang cosmology as an original epistemic quantum information theoretic model of the cosmos. The model is relation-based (not object-based) and is fundamentally established on foundations of positive and negative correlations between correlates. Adopting the holographic principle of 't Hooft, the fundamental dualistic processes of Yin Yang cosmology are interacting self-assembly (host) and self-disassembly (virus) subroutines in a superposition algorithm that cooperate in a phase portrait on a holographic boundary. This cooperative self-assembly and self-disassembly Yin Yang cosmology is formalized in a pair of differential equations that plot as orthogonal swirling Taijitu, and which together form an epistemic information-accreting unit-circle limit-cycle. Formal and natural descriptions are given for the continuously evolving saturation of quantum information entropy production under Yin Yang theoretic unit circle limit cycle dynamics. This original paper includes a short discussion on the known cosmos, from Big Bang to thermodynamic Big Chill, which is a quarter-cycle in Yin Yang cosmology. Our known thermodynamic cosmos is contextualized within a Yin Yang full-oscillation stationary wave that self-evolves, both its content (correlations between correlates) and its emergent laws, all-at-once in superposition. In a general theory of thermodynamics, the four superposed quarter-cycles of Yin Yang cosmology are: thermodynamic (the known cosmos), cryodynamic, anti-thermodynamic and anti-cryodynamic. Yin Yang cosmology guided by its epistemic limit cycle, self-evolves towards a self-referential symbolic ouroboros of quantum cosmological intelligence and generates Hawking's *ex post facto* configurations for Life.

Keywords

Quantum Information, Superposition, Self-Assembly, Self-Disassembly, Thermodynamics, Entropy, Life, Epistemology, Holographic Principle, Limit Cycle, Ouroboros, Retrocausality

1. Introduction

Niels Bohr (1885-1962) was an exceptional 20th century physicist-philosopher, who influentially investigated atomic structure and developed quantum theory, for which he received a Nobel Prize in 1922. Related to his philosophical perspectives on dualism, Taoism and Buddhism, and his Principle of Complementarity, Bohr respectfully adopted the Taijitu symbol of Yin Yang as his insignia [1].

In this paper I consider an original quantum information theoretic model of the cosmos and with humble due deference call it Yin Yang cosmology. The model is fundamentally established on foundations of negative and positive correlations between “correlates” (*plural noun*). Yin Yang cosmology is not object-based, it is relation-based, or relational [2].

I adopt the holographic principle of ‘t Hooft, (see a review by Bousso [3]), from which the three-dimensional world is a hologram that is a dynamic image of reality encoded upon a remote two-dimensional boundary. The fundamental processes of Yin Yang cosmology are interacting self-assembly (host) and self-disassembly (virus) subroutines in a dualistic all-at-once superposition algorithm. These subroutines cooperate with complementarity [4] in a phase portrait on a remote holographic boundary.

To provide some generally related background reading, the following is a non-exhaustive, diverse sample from pertinent research into self-assembly and self-disassembly, including of correlations, positive and negative.

Pires and Duarte Queirós [5] investigate the emerging properties of quantum walks with temporal disorder engineered from a binary Markov chain with tailored correlation and disorder strength. They show that negatively correlated disorder plays a significant role in quantum entanglement.

Liu & Yao, [6] consider ensemble learning via negative correlation in neural networks.

Aschwanden and colleagues present a comprehensive review of self-organization processes in astrophysics, order out of randomness [7].

Charalambidis leads a report in the field of artificial, self-assembling, light-harvesting systems [8], specifically on a switchable self-assembling and disassembling chiral system based on a porphyrin-substituted phenylalanine-phenylalanine motif.

England considers dissipative adaptation in driven self-assembly [9] and proposes a general thermodynamic mechanism for self-organization via dissipation of absorbed work applicable across classes of driven many-body systems.

Conway’s well-known Game of Life [10] is a zero-player game that evolves from initial conditions by application of cellular automaton neighbour rules. These games evolve to exhibit complex self-assembly and self-disassembly, (see also ‘t Hooft [11] for his use of cellular automata in a seminal model for dimensional reduction in quantum gravity).

In the following and corresponding formalisations of Yin Yang cosmology,

self-assembly is denoted \mathfrak{a} , α or a , and self-disassembly is denoted \mathfrak{b} , β or b . Relational correlations in a Yin Yang all-at-once superposition algorithm are denoted \mathfrak{a} and \mathfrak{b} , whereas α and β are used in a corresponding formalisation of a pair of nonlinear differential equations representing Yin Yang cosmology. A unit circle limit cycle formalisation established upon those Yin Yang cosmology differential equations uses a and b .

Following this introduction (Section 1), the paper provides a description of Yin Yang cosmology from related perspectives: superposition algorithm (Section 2); pair of differential equations (Section 3); unit circle limit cycle (Section 4); entropy saturation (Section 5); phenomenology (Section 6); time-reversal invariance (Section 7); and conclusions (Section 8).

2. Superposition Algorithm

Yin Yang cosmology modelling first considers an all-at-once superposition of simple rules (Figure 1 and Algorithm 1) that govern evolving complementary processes of self-assembly and self-disassembly. Yin Yang cosmology, in its entirety, is defined to be time reversal invariant (Section 7), correspondingly its algorithm is defined to be in all-at-once superposition. The model focuses on

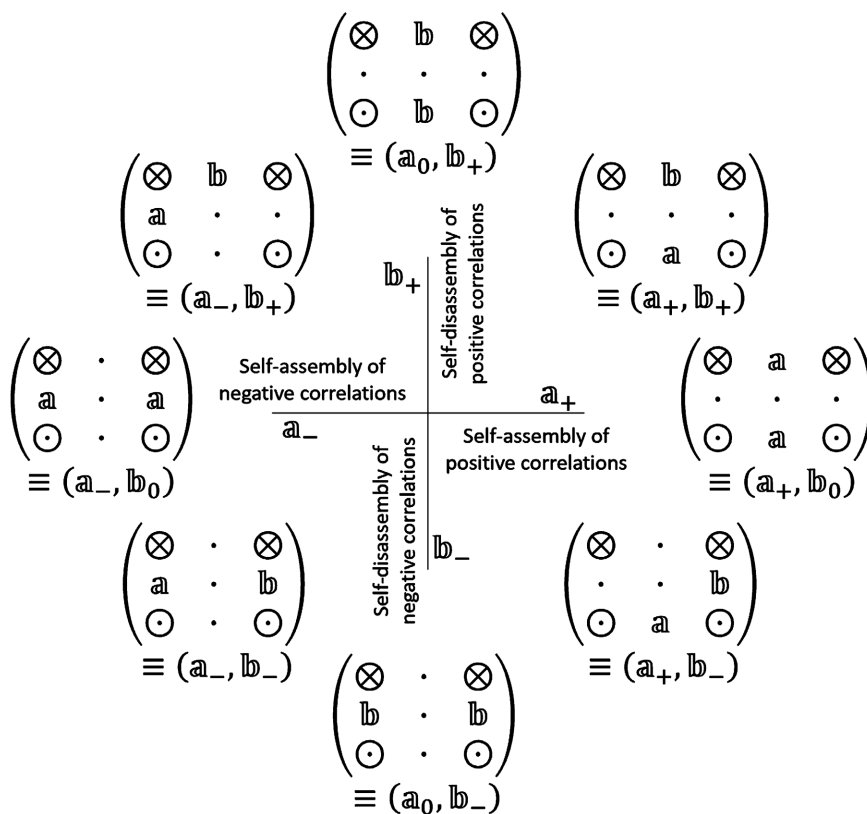


Figure 1. A dualistic all-at-once superposition algorithm governs Yin Yang cosmology. It comprises relational (not object-based) fundamental processes that are self-assembly and self-disassembly of positive and negative correlations. Superposed phases $(\mathfrak{a}_{-,0,+}, \mathfrak{b}_{-,0,+})$ of the superposition algorithm process correlations \mathfrak{a} and \mathfrak{b} , between correlates \otimes and \odot . The three “.” symbols in each 3×3 array denote empty cells.

- Phase (a_+, b_0) processes only self-assembly of positive correlations, $\otimes a \otimes$ and $\odot a \odot$, with zero or no self-disassembly,

$$\begin{pmatrix} \otimes & a & \otimes \\ \cdot & \cdot & \cdot \\ \odot & a & \odot \end{pmatrix} \equiv (a_+, b_0)$$

- Phase (a_+, b_+) processes self-assembly of positive correlations, $\odot a \odot$, and self-disassembly of positive correlations, $\otimes b \otimes$,

$$\begin{pmatrix} \otimes & b & \otimes \\ \cdot & \cdot & \cdot \\ \odot & a & \odot \end{pmatrix} \equiv (a_+, b_+)$$

- Phase (a_0, b_+) processes zero or no self-assembly with only self-disassembly of positive correlations, $\otimes b \otimes$ and $\odot b \odot$,

$$\begin{pmatrix} \otimes & b & \otimes \\ \cdot & \cdot & \cdot \\ \odot & b & \odot \end{pmatrix} \equiv (a_0, b_+)$$

- Phase (a_-, b_+) processes self-assembly of negative correlations, $\otimes a \odot$, and self-disassembly of positive correlations, $\otimes b \otimes$,

$$\begin{pmatrix} \otimes & b & \otimes \\ a & \cdot & \cdot \\ \odot & \cdot & \odot \end{pmatrix} \equiv (a_-, b_+)$$

- Phase (a_-, b_0) processes only self-assembly of negative correlations, $\otimes a \odot$, with zero or no self-disassembly,

$$\begin{pmatrix} \otimes & \cdot & \otimes \\ a & \cdot & a \\ \odot & \cdot & \odot \end{pmatrix} \equiv (a_-, b_0)$$

- Phase (a_-, b_-) processes self-assembly of negative correlations, $\otimes a \odot$, and self-disassembly of negative correlations, $\otimes b \odot$,

$$\begin{pmatrix} \otimes & \cdot & \otimes \\ a & \cdot & b \\ \odot & \cdot & \odot \end{pmatrix} \equiv (a_-, b_-)$$

- Phase (a_0, b_-) processes zero or no self-assembly with only self-disassembly of negative correlations, $\otimes b \odot$,

$$\begin{pmatrix} \otimes & \cdot & \otimes \\ b & \cdot & b \\ \odot & \cdot & \odot \end{pmatrix} \equiv (a_0, b_-)$$

- Phase (a_+, b_-) processes self-assembly of positive correlations, $\odot a \odot$, and self-disassembly of negative correlations, $\otimes b \odot$,

$$\begin{pmatrix} \otimes & \cdot & \otimes \\ \cdot & \cdot & b \\ \odot & a & \odot \end{pmatrix} \equiv (a_+, b_-)$$

Algorithm 1. Yin Yang superposition algorithm comprising superposed phases of relational processes of self-assembly and self-disassembly of positive and negative correlations.

correlations between correlates. Fundamental relationships between correlates are self-assembled and self-disassembled, and correlations are both positive and negative.

All correlates are here denoted by one of two proxies, \otimes or \odot . It is helpful to imagine the proxy correlates as facing respectively into, \otimes , and out of, \odot , a phase portrait on the holographic boundary.

This binary proxy approach to pairs of correlates enables a concise formalisa-

tion of positive and negative correlations. In the later discussion on phenomenology (Section 6) the manifestation of correlates in our experienced version of reality comprises a zoo of particles to galaxies. In this section, subordinate binary proxy correlates suffice to define the superior correlations.

Considered in pairs, $\otimes\otimes$, $\otimes\odot$, $\odot\otimes$ and $\odot\odot$, these correlates either correlate positively, $\otimes\otimes$, $\odot\odot$, or correlate negatively, $\otimes\odot$, $\odot\otimes$. Recall, relationships are more fundamental than the individual correlates in Yin Yang cosmology. The subordinate correlates simply bestow the superior correlations their distinction and sign, either positive or negative. It is the information rich correlations which constitute and evolve fundamental knowledge in the epistemic Yin Yang cosmos, less so its subordinate correlates.

Presently, we return to the interacting self-assembly (host) and self-disassembly (virus) subroutines in a dualistic all-at-once superposition algorithm, cooperating in a phase portrait on the holographic boundary.

Yin Yang cosmology is formalised in this section as superposed phases ($\mathbb{a}_{-,0,+}$, $\mathbb{b}_{-,0,+}$) of an all-at-once superposition algorithm which processes correlations \mathbb{a} and \mathbb{b} , between correlates \otimes and \odot . The three “.” symbols in each 3×3 array denote empty cells (**Algorithm 1**).

In Yin Yang cosmology it is proposed that the superposed phases ($\mathbb{a}_{-,0,+}$, $\mathbb{b}_{-,0,+}$) of the superposition algorithm process correlations \mathbb{a} and \mathbb{b} , between correlates \otimes and \odot all-at-once. The epistemically driven Yin Yang cosmos self-evolves towards a self-referential [12], self-learning, circular, symbolic ouroboros of increasing quantum cosmological intelligence. Tail-biting serpent symbols (like the ouroboros) in ancient and modern civilisations, eastern and western, symbolise eternal natural cycles.

3. Differential Equations

Relational correlations in the Yin Yang all-at-once superposition algorithm above (Section 2) are denoted \mathbb{a} and \mathbb{b} , whereas α and β are used here (Section 3) in a corresponding formalisation of a pair of nonlinear differential equations representing Yin Yang cosmology. Self-assembly, α , and self-disassembly, β , are formalised as a corresponding and governing pair of nonlinear differential equations (Equation (1)), with contour plots resembling an orthogonal pair of anti-clockwise swirling Taijitu, or Yin Yang symbols (**Figure 2**).

$$\begin{cases} \alpha' := \alpha(1 - \alpha^2 - \beta^2) - \beta \\ \beta' := \beta(1 - \alpha^2 - \beta^2) + \alpha \end{cases} \quad (1)$$

A streamline plot of the vector field in the phase portrait is shown in **Figure 3**.

We may alternatively and more concisely write Equation (1) as a pair of differential equations in polar coordinates:

$$\begin{cases} r' := r(1 - r^2) \\ \theta' := 1 \end{cases} \quad (2)$$

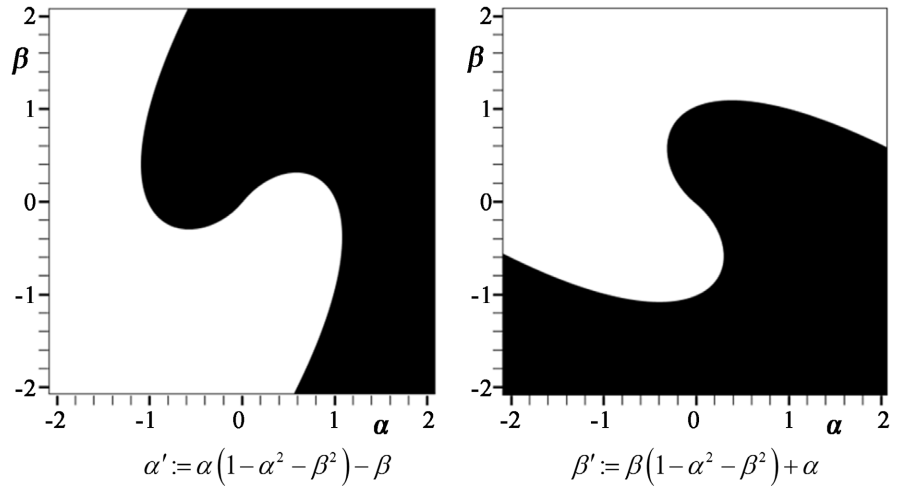


Figure 2. Self-assembly, α (horizontal axes), and self-disassembly, β (vertical axes), are defined as a pair of nonlinear differential equations (Equation (1)), with corresponding contour plots resembling an orthogonal pair of anticlockwise swirling Taijitu, or Yin Yang symbols.

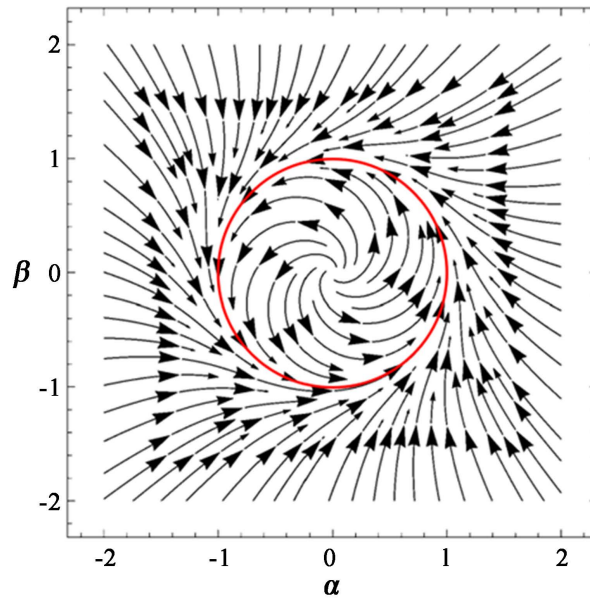


Figure 3. Streamline plot of the anticlockwise vector field in the Yin Yang cosmology phase portrait of a definitive pair of nonlinear differential equations (Equation (1)). Self-assembly, α , is plotted along the horizontal axis and self-disassembly, β , is plotted along the vertical axis. Note that a closed trajectory limit-cycle in the vector field coincides with the unit circle (red). The red circle, or symbolic ouroboros, represents an epistemically driven accretion ring of knowledge that creates the self-referential quantum cosmological intelligence of the Yin Yang cosmos.

where $r^2 = \alpha^2 + \beta^2$, $\tan \theta = \beta/\alpha$, $r' = (\alpha\alpha' + \beta\beta')/r$ and $\theta' = (\alpha\beta' - \beta\alpha')/r^2$. Furthermore, quantization of self-assembly, α , and self-disassembly, β , orthodoxly maps as follows:

$$\{\alpha, \beta\} \mapsto \frac{1}{i\hbar} [\hat{\alpha}, \hat{\beta}] \tag{3}$$

4. Unit Circle

Let us now consider the development of this Yin Yang cosmology as a vector field (**Figure 3**) in the phase portrait which flows anticlockwise in the limit towards the unit circle. Later we shall discuss this unit circle (highlighted in red in **Figure 3**) in terms of an epistemic accretion ring, or self-referential symbolic ouroboros of quantum cosmological intelligence. We consider the convergent anticlockwise flow towards the unit circle as enabling *flow refinement*, or granularity reduction, of a Yin Yang cosmological quantum information network. The combination of epistemic accretion and refinement by convergent flow, unifies, parallelises, compactifies and denoises the cosmos' complex information evolution (cf. self-application of Occam's razor). Snowballing knowledge accretion, with continuous information *flow refinement*, constitutes the self-referential basis of self-learning, and complementary self-instructing, within the definition of increasing Yin Yang cosmological intelligence. In consideration of the all-at-once superposition algorithm (**Figure 1** and **Algorithm 1**), Yin Yang cosmology envisages the entire two dimensional α, β phase portrait on the holographic boundary as operationally possible. In other words, no correlation between its correlatable correlates is prohibited, enabling Nature's abundant possible dynamic information theoretic configurations. Note, as the superposition algorithm self-referentially updates, through its superposed phases of processing, whilst self-learning and optimising for fundamental quantum epistemic advantage (Sections 6 & 7), universal knowledge accretes in the unit circle limit cycle in the α, β phase portrait, building increasing quantum cosmological intelligence.

The standard parametric formalisation of the unit circle is adopted as follows. We now replace a with a , (both representing self-assembly), and replace β with b , (both representing self-disassembly), as we simplify Yin Yang cosmology from the vector field in the streamline plot (**Figure 3**), to focus on its limit cycle, the unit circle (**Figure 4**).

The phase angle ϕ in the unit circle is measured as positive anticlockwise from the positive direction of the horizontal a axis (**Figure 4**) and standard parametric formalisation of the unit circle gives:

$$a = \cos \phi \quad (4)$$

$$b = \sin \phi \quad (5)$$

Note, self-disassembly, $b = \sin \phi$, is phase shifted by a quarter-cycle relative to self-assembly, $a = \cos \phi$.

The four quarter-cycles \mathbb{u} , \mathbb{v} , \mathbb{x} & \mathbb{y} (**Figure 4**) each have mixed processes as information is transformed in superposition within the entire cycle. This unit circle foundation of Yin Yang cosmology is expected to respect the fundamental symmetry of physical laws under simultaneous transformations of charge conjugation, parity transformation, and time reversal (CPT symmetry). All together in Yin Yang cosmology the quarter-cycles \mathbb{u} , \mathbb{v} , \mathbb{x} & \mathbb{y} , for the entire cosmos, through $0 \leq \phi \leq 2\pi$, respect Schwinger's quantum action principle [13]. Furthermore,

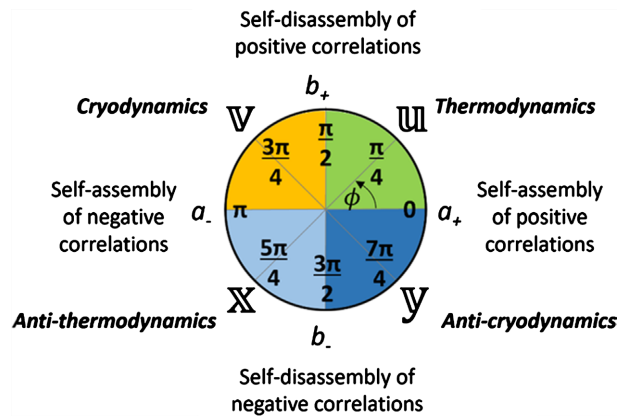


Figure 4. Unit circle representing the limit-cycle (red) in **Figure 3**. The horizontal axis, a_{\pm} , represents self-assembly of positive correlations, a_{+} , (right), through self-assembly of negative correlations, a_{-} , (left). The vertical axis, b_{\pm} , represents self-disassembly of positive correlations, b_{+} , (up), through self-disassembly of negative correlations, b_{-} , (down). The phase angle, ϕ , is measured as positive anticlockwise from the positive a_{+} axis. The unit circle bounds a disc which is segmented into four quarter-cycles III , II , X , Y , respectively coloured green, yellow, light blue and dark blue, and respectively representing the thermodynamics of the known cosmos, and Yin Yang theoretic cryodynamics, anti-thermodynamics and anti-cryodynamics.

it is proposed that correlative arcs of the unit circle limit cycle (**Figure 3** & **Figure 4**), together with the all-at-once superposition algorithm (**Algorithm 1**) of Yin Yang cosmology, are foundational to quantum non-locality in spacetime.

4.1. Quarter-Cycle III

As the phase angle, ϕ , increases from 0 to $\pi/2$, the quarter-cycle III has decreasing self-assembly of positive correlations, $\downarrow a_{+}$, with increasing self-disassembly of positive correlations, $\uparrow b_{+}$. This is the familiar thermodynamic quarter-cycle in Yin Yang cosmology, between the Big Bang and the Big Chill.

However, quarter-cycles II , X & Y are not classically thermodynamic and so a general theory of thermodynamics arises as follows.

4.2. Quarter-Cycle II

As the phase angle, ϕ , increases from $\pi/2$ to π , quarter-cycle II has increasing self-assembly of negative correlations, $\uparrow a_{-}$, with decreasing self-disassembly of positive correlations, $\downarrow b_{+}$. This is an unfamiliar cryodynamic phase in the evolution of our cosmos. We note Rössler’s broadly related discussion on cryodynamics and cosmology [14].

4.3. Quarter-Cycle X

As the phase angle, ϕ , increases from π to $3\pi/2$, quarter-cycle X has decreasing self-assembly of negative correlations, $\downarrow a_{-}$, with increasing self-disassembly of negative correlations, $\uparrow b_{-}$. This is another unfamiliar phase in the evolution of our cosmos. It is phase shifted with respect to the known thermodynamic quar-

ter-cycle \mathfrak{u} by angle π . Quarter-cycle \mathfrak{x} in Yin Yang cosmology is here coined anti-thermodynamic.

4.4. Quarter-Cycle \mathfrak{y}

As the phase angle, ϕ , increases from $3\pi/2$ to 2π , quarter-cycle \mathfrak{y} has increasing self-assembly of positive correlations, $\uparrow a_+$, with decreasing self-disassembly of negative correlations, $\downarrow b_-$. This is another unfamiliar phase in the evolution of our cosmos. It is phase shifted with respect to the cryodynamic quarter-cycle \mathfrak{v} by angle π . Quarter-cycle \mathfrak{y} in Yin Yang cosmology is here coined anti-cryodynamic.

5. Entropy Saturation

Let us now consider the parametric equations (Equation (4) & Equation (5)) as representing information theoretic continuous functions [15] [16]. In Yin Yang cosmology, for the purpose of formalising the continuously evolving saturation of quantum information entropy production under Yin Yang theoretic unit circle limit cycle dynamics (Yin Yang entropy saturation), the following are defined:

$$\mathbb{E}_{YY} := a = \cos \phi \quad (6)$$

$$I_{YY} := \ln \frac{1}{b} = \ln \csc \phi \quad (7)$$

This model cosmology defines the Yin Yang expected value operator, \mathbb{E}_{YY} , and the Yin Yang self-information, I_{YY} , as a pair of simple log-trigonometric functions of the phase angle ϕ , which scribes the unit circle limit cycle of its defining pair of nonlinear differential equations (Equation (1)). The subscript YY represents that the definitions are specific to the Yin Yang cosmology model. The conventional definition of information entropy [15] applies in the familiar thermodynamic quarter-cycle \mathfrak{u} . However, the definitions in Equations (6) & (7) consider all four quarter-cycles \mathfrak{u} , \mathfrak{v} , \mathfrak{x} & \mathfrak{y} , which include quarter-cycles \mathfrak{v} , \mathfrak{x} & \mathfrak{y} that are not classically thermodynamic.

Equations (6) & (7) are plotted as functions of ϕ in **Figure 5** and parametrically in **Figure 6**.

Note in **Figure 5** that the expected value operator \mathbb{E}_{YY} (blue) has periodicity 2π and maxima at $\phi = n2\pi$, where n is an integer. The imaginary part of I_{YY} (green) also has periodicity 2π stepping abruptly between a floor at $\text{Im } I_{YY} = 0$ and a ceiling (coinciding with positive gradients in \mathbb{E}_{YY}) where $\text{Im } I_{YY} = \pi i$. Also note that the real part of the Yin Yang self-information, $\text{Re } I_{YY}$ (purple), has periodicity π , so it completes two cycles within one cycle of \mathbb{E}_{YY} (blue). Maxima of the real part of the Yin Yang self-information, $\text{Re } I_{YY}$ (purple), explode to positive infinity at $n\pi$, where n is an integer, whereas the minima are differentiable turning points, where both $\text{Re } I_{YY} = 0$ and $\mathbb{E}_{YY} = 0$.

Note in **Figure 6** that the parametric plot of Equation (6) & (7) is a single differentiable curve. Over infinite cycles of phase ϕ the parametric curve forms one U-shape, which ranges between $-1 \leq \mathbb{E}_{YY} \leq 1$ and $0 \leq I_{YY} \leq +\infty$, such is

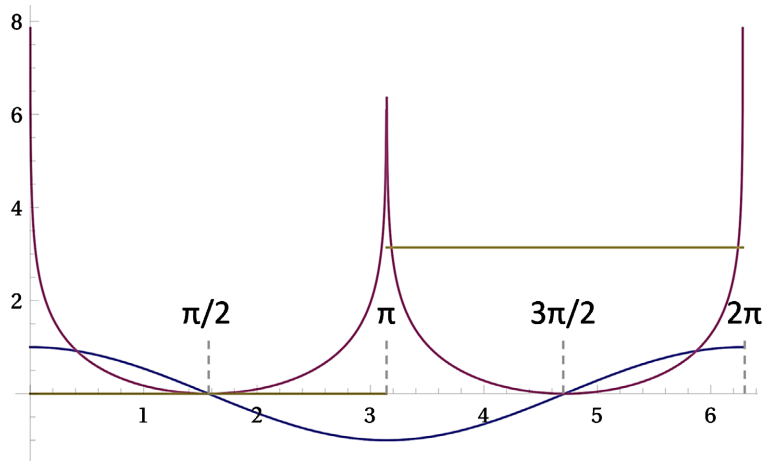


Figure 5. The plot shows the real and imaginary parts of Equations (6) & (7). The blue curve represents the Yin Yang expected value operator $\mathbb{E}_{YY} := \cos \phi$ plotted against ϕ . The purple curves represent the real part of the Yin Yang self-information, $I_{YY} := \text{Re}(\ln \csc \phi)$ plotted against ϕ and the green stepped profile represents the imaginary part of the Yin Yang self-information, $I_{YY} := \text{Im}(\ln \csc \phi)$ plotted against ϕ .

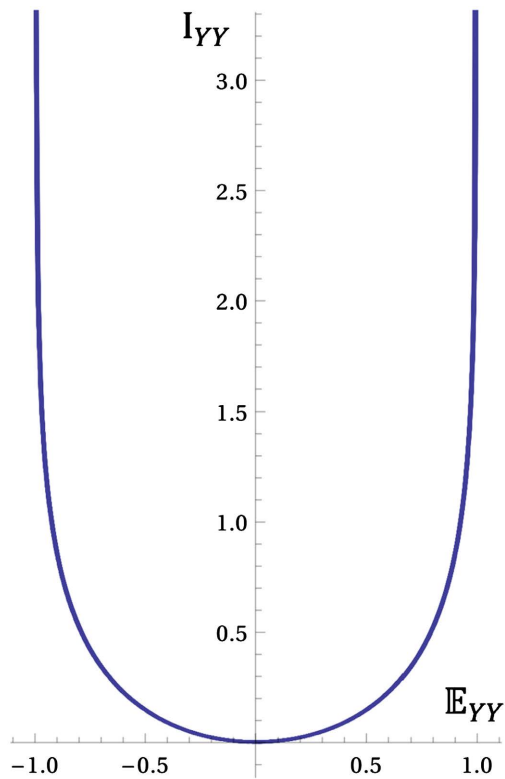


Figure 6. Parametric plot of Equations (6) & (7). The Yin Yang expected value operator \mathbb{E}_{YY} is represented on the horizontal axis. Yin Yang self-information I_{YY} is represented on the vertical axis.

the simple symmetrical parametric dynamic of Yin Yang Cosmology.

The right side of the U-shape as $I_{YY} \rightarrow +\infty$ represents the peak of self-assembly of positive correlations. The left side of the U-shape as $I_{YY} \rightarrow +\infty$ represents

the peak of self-assembly of negative correlations. The minimum turning point of the U-shape where, $I_{YY} = \mathbb{E}_{YY} = 0$, represents zero self-assembly.

As the Yin Yang cycle evolves anticlockwise on the unit circle, with increasing phase angle ϕ , (Figure 4) the cycle correspondingly evolves on the I_{YY} versus \mathbb{E}_{YY} parametric plot (Figure 6) as follows. From the top right extrema (maximum self-assembly of positive correlations and zero self-disassembly) the evolution rolls down thermodynamically through the minimum turning point at the quarter cycle (zero self-assembly and maximum self-disassembly of positive correlations). It then rolls up cryodynamically to the top left extrema (maximum self-assembly of negative correlations and zero self-disassembly). The evolution then rolls back down anti-thermodynamically from the top left extrema through the minimum turning point again (zero self-assembly and maximum self-disassembly of negative correlations). It then rolls back up anti-cryodynamically to the right extrema, to complete the unit circle limit cycle at the maximum self-assembly of positive correlations and zero self-disassembly.

In summary, for one cycle on the unit circle (Figure 4), Yin Yang cosmology evolves on the I_{YY} versus \mathbb{E}_{YY} parametric plot (Figure 6) by rolling down from the top right of the U-shape ($\phi = 0$), through the minimum ($\phi = \pi/2$) to the top left ($\phi = \pi$), then back down through the minimum ($\phi = 3\pi/2$) and back up to the top right ($\phi = 2\pi$).

The continuously evolving saturation of quantum information entropy production under Yin Yang theoretic unit circle limit cycle dynamics, or for short, Yin Yang entropy saturation, $h_{YY}(\phi)$, is now defined:

$$h_{YY}(\phi) = \mathbb{E}_{YY} [I_{YY}(\phi)] = \int a \ln \frac{1}{b} d\phi \quad (8)$$

and by substitution (Equations (6) & (7)):

$$h_{YY}(\phi) = \int \cos \phi \ln \csc \phi d\phi \quad (9)$$

alternatively:

$$h_{YY}(\phi) = (1 + \ln \csc \phi) \sin \phi \quad (10)$$

A real-value plot of $h_{YY}(\phi)$ versus ϕ over the quarter-cycle \mathbb{u} , where $0 \leq \phi \leq \pi/2$ is shown in Figure 7.

Note in Figure 7 and Equations 8, 9 & 10, that the Yin Yang entropy saturation, $h_{YY}(\phi) = \int a \ln \frac{1}{b} d\phi$, evolves to $h_{YY}^{\max}(\phi) = 1$ as ϕ increases from 0 to $\pi/2$. This cosmology model considers $h_{YY}^{\max}(\phi) = 1$ as the maximum saturation of quantum information entropy production under Yin Yang theoretic unit circle limit cycle dynamics. The reader is referred to Kaneko and co-workers [17] for a study of the saturation of entropy production in quantum many-body systems.

The reader is also referred to Schreiber [18] on measuring information transfer and to Yang, Peng & Haung [19] on causal decomposition in mutual causation systems.

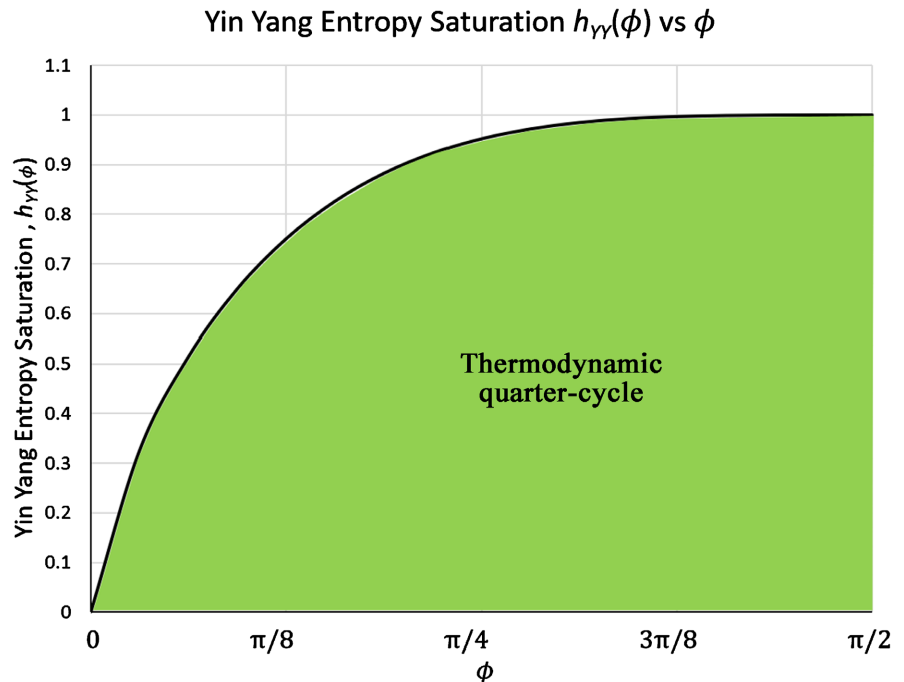


Figure 7. Real-value plot of $h_{YY}(\phi)$ versus ϕ over the quarter-cycle \mathbb{U} , where $0 \leq \phi \leq \pi/2$. Note Yin Yang entropy saturation evolves to $h_{YY}^{\max}(\phi) = 1$ as ϕ increases from 0 to $\pi/2$. The green shaded area corresponds to that in **Figure 4** & **Figure 8** and shows the thermodynamic quarter-cycle \mathbb{U} of the known cosmos.

6. Phenomenology

With reference to **Figure 7**, in our thermodynamic known cosmos, the state where $\phi = 0$ and $h_{YY}(\phi) = 0$ represents a state of zero-saturation of entropy production at the Big Bang [20]. Whereas, in our thermodynamic known cosmos the state where $\phi = \pi/2$ and $h_{YY}^{\max}(\phi) = 1$ represents the state at its expected Big Chill [21], a state of maximum entropy saturation in which no further thermodynamic work can purportedly occur.

The interval of evolution in Yin Yang cosmology ranging from $\phi = 0$ (cf. Big Bang) to $\phi = \pi/2$ (cf. Big Chill) relates to the known thermodynamic quarter-cycle \mathbb{U} , where the entropy of the physical cosmos increases from zero to a maximum value ($h_{YY}^{\max}(\phi) = 1$), (**Figure 7**). Of note, the second law of thermodynamics irrefutably prevails where $0 \leq \phi \leq \pi/2$. Biological Life, amongst other familiar physical and chemical processes, thrives in the thermodynamic quarter-cycle \mathbb{U} .

A characteristic of Yin Yang cosmology, however, is that it is a superposition oscillating model which describes the evolution of Yin Yang entropy saturation, as a complex number, with real and imaginary parts. **Figure 8** shows this oscillating Yin Yang cosmology evolution as $h_{YY}(\phi)$ versus ϕ plotted over the range $0 \leq \phi \leq 2\pi$. See also **Figure 4** for the unit circle representation of this same Yin Yang oscillation.

The evolution of Yin Yang entropy saturation $h_{YY}(\phi)$ is familiar over the

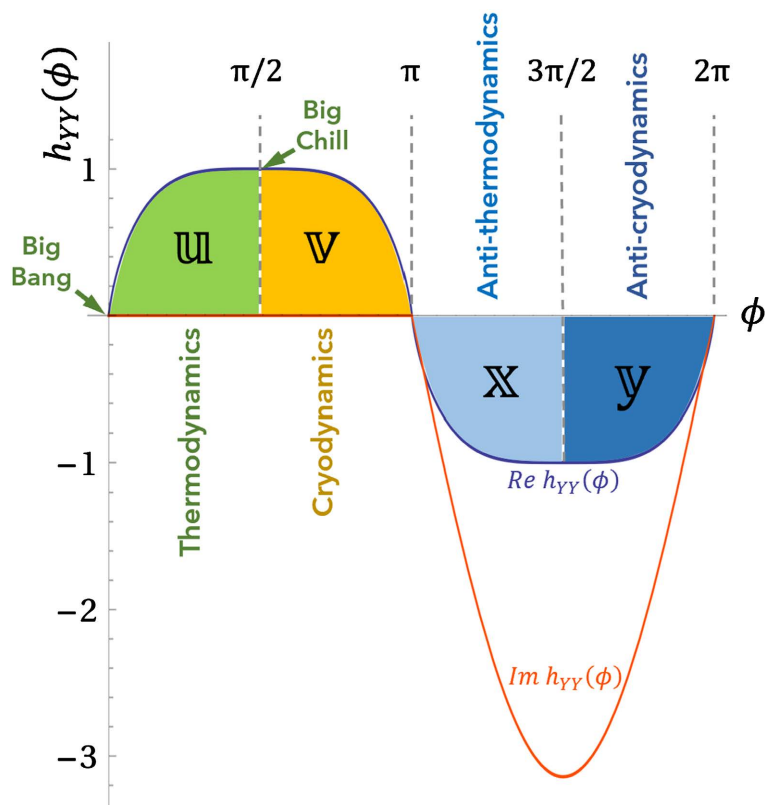


Figure 8. Real (blue) and imaginary (orange) values plot of $h_{YY}(\phi)$ versus ϕ over the range $0 \leq \phi \leq 2\pi$, (Equations (8)-(10)). Note Yin Yang entropy saturation $h_{YY}(\phi)$ evolves in cycles with periodicity 2π . The four quarter-cycles \mathfrak{u} , \mathfrak{v} , \mathfrak{x} & \mathfrak{y} (Figure 4) are shown. The green shaded area, \mathfrak{u} , is equivalent to that in Figure 7 and shows the known thermodynamic quarter-cycle of the cosmos. According to Yin Yang cosmology, the yellow shaded area, \mathfrak{v} , represents the cryodynamic quarter-cycle; the light blue shaded area, \mathfrak{x} , represents the anti-thermodynamic quarter cycle; and the dark blue shaded area, \mathfrak{y} , represents the anti-cryodynamic quarter-cycle.

range $0 \leq \phi \leq \pi/2$, evolving thermodynamically from zero to level out towards a maximum value ($h_{YY}^{\max}(\phi) = 1$), (Figure 7). However, over the wider range $0 \leq \phi \leq 2\pi$, (Figure 8), we note it has periodicity 2π , including intervals of increasing, decreasing and negative Yin Yang entropy saturation (real and imaginary). The real part $-1 \leq \text{Re } h_{YY}(\phi) \leq 1$ and the imaginary part $-\pi i \leq \text{Im } h_{YY}(\phi) \leq 0$ of the Yin Yang entropy saturation $h_{YY}(\phi)$ are shown in Figure 8, in blue and orange respectively.

In statistical physics, connecting microscopic reversible dynamics and the second law of thermodynamics has been an enduring problem. Let us suspend intuition and permit consideration of such an oscillating Yin Yang cosmology model comprising fundamental processes of self-assembly and self-disassembly (Figure 4 & Figure 8). Recall, this is a relational cosmology model, rather than object-based, where the bases of self-assembly and self-disassembly are correlations between correlates, both positive and negative (Figure 1).

Yin Yang cosmology proposes that the currently expected laws of thermody-

namics are incomplete and only applicable as currently formulated during the known quarter-cycle, \mathfrak{u} , of the cosmos, where $0 \leq \phi \leq \pi/2$, (**Figure 4** & **Figure 8**). More general physical laws of thermodynamics (including cryodynamics, anti-thermodynamics, and anti-cryodynamics), within Yin Yang cosmology and its continuously evolving saturation of quantum information entropy production under Yin Yang theoretic unit circle limit cycle dynamics (Equations (8)-(10)) clearly invite further study, beyond the scope of this introductory paper.

Considering our understanding of the known cosmos, limited to that which we thermodynamic beings may experience within quarter-cycle \mathfrak{u} , what more can already be said about the non-thermodynamics of the other three quarter-cycles \mathfrak{v} , \mathfrak{x} & \mathfrak{y} ? These non-thermodynamic quarter cycles are highly counter-intuitive to us thermodynamic beings and will require an evolved scientific language. In future research, we could start tackling this problem by considering the unit circle symmetries of Yin Yang cosmology (**Figure 4**). Noether's first theorem which relates physical system symmetries and conservation laws should also be applied. Starting with the known laws of thermodynamics, their rotations about the centre of the unit circle and reflections across the axes of self-assembly and self-disassembly (**Figure 4**), should enlighten us about thermodynamics' corresponding hypothetical laws of cryodynamics, anti-thermodynamics, and anti-cryodynamics, within Yin Yang cosmology.

In Yin Yang cosmology, the complex emergent zoo of apparent physical correlates (e.g. from particles to galaxies in the thermodynamic quarter-cycle) is not as fundamental as their limit-cycle circling swarm of evolving correlations. Nonetheless, the innumerable dynamic correlations throughout that zoo make the evolving hologram (that is a dynamic image of reality) increasingly attractive (*sensu stricto*), accreting its advantageous information content, for a self-referential symbolic ouroboros of increasing quantum cosmological intelligence (red accretion ring, **Figure 3**).

Consider the attractive hologram as corresponding with the Yin Yang epistemic attractor, or self-learning orbit in the phase portrait on the holographic boundary. The epistemically driven accretion ring of knowledge, or symbolic ouroboros that is the self-referential quantum cosmological intelligence of the cosmos, has an insatiable appetite for accreting advantageous knowledge.

7. Time-Reversal Invariance

During the known thermodynamic quarter-cycle of the cosmos, $0 < \phi < \pi/2$, (green shaded area, \mathfrak{u} , in **Figure 4** & **Figure 8**), our conscious relationship with increasing Yin Yang entropy saturation $h_{YY}(\phi)$ manifests as the experience of an arrow-of-time. More generally and precisely however, Equations (8)-(10) are time invariant and indeed time-reversal invariant. Phase ϕ is not an amount of time counted by ticks on a clock, instead ϕ is an angle which defines the orientation of a unit vector. That vector scribes a unit circle, which represents the limit cycle, where interacting self-assembly, α , and self-disassembly, β , constitute

a pair of nonlinear differential equations (Equation (1)). These differential equations determine the limit cycle and the corresponding Yin Yang contour plots (**Figure 2**). Time is not fundamental in Yin Yang cosmology, time is emergent.

Furthermore, observed dynamics of the cosmos are time-reversal invariant [22], and as Hertog discusses in his book on the origin of time (Hawking's final theory) [23], they contend that time emerges in an *ex post facto* manner, that is the past is contingent on the present, not *vice versa*. In this context, **Figure 8** represents a stationary wave, an all-at-once superposition, which is epistemically fine-tuning itself, like a self-referential symbolic ouroboros, to self-optimize the cosmos for the intrinsic gain of advantageous knowledge, the *ex post facto* configuration for Life and quantum cosmological intelligence. Advantageous knowledge is that which enables the Yin Yang cosmos to out-compute (*sic*) alternatives, through minimising differences between the Yin Yang cosmos' intrinsic predictions and outcomes, both causally and retro-causally, while governed by Schwinger's quantum action principle [13].

Our perceived experience of an arrow-of-time is proposed in Yin Yang cosmology to have its origins in thermodynamically rectified net-cumulative self-assembly and self-disassembly of correlations, positive and negative. The concept of thermodynamic signal rectification is key. Signals between correlates are time-reversal symmetric, but only where transcending across the entirety of the four quarter-cycles of the all-at-once superposition oscillation that is the Yin Yang cosmos (**Figure 4 & Figure 8**). However, trapped as we biological organisms are, within the thermodynamic quarter-cycle of that cosmos (**Figure 7**), thermodynamic observers, thermodynamic participants, and thermodynamic devices, including thermodynamic clocks, can physically do nothing other than process thermodynamically rectified signals. For thermodynamic participants in the thermodynamic quarter-cycle \mathfrak{u} , including biological organisms, this reinforces their illusion of the arrow-of-time. To be liberated from rectified thermodynamic worldlines, transcendent participants and their transcendent devices need to utilise non-thermodynamic quantum information systems.

For biological organisms, self-assembly and self-disassembly of correlations are competing information theoretic processes, like host and virus algorithms. They generally build beneficial memory resources and knowledge that organisms leverage in predictive mental models of the world, to anticipate, survive, replicate, and proactively participate in the quarter-cycle \mathfrak{u} of the Yin Yang cosmos. It is our proactive, thermodynamically rectified, information-foraging wandering across the Yin Yang phase space which gives us our perceived experience of an arrow-of-time, which emerges from forward cumulative information-foraging in our epistemic ramble. We have an insatiable appetite for accumulating advantageous knowledge, which creates our illusion of the passing of time, as memories are deposited (via self-assembly) whilst eroded (via disassembly), like a dynamic stratigraphy, neural layer upon neural layer.

To biological organisms, time thus feels categorically and thermodynamically rectified, like geology, accumulated through successively layered deposits. We

are constrained as we forage for advantageous information over the broad and diverse Yin Yang landscape. Our thermodynamic biochemical processes are much more classical than quantum and this blinkers us from most non-local retro-causal experiences. However, Yin Yang cosmology proposes that non-local retro-causal events are all around us; rich, dynamic, and omnipresent. They are there, Popper falsifiable, to be accessed, through non-thermodynamic quantum mechanics experiments, quantum computing and via altered states of mind.

The four quarter-cycles \mathfrak{u} , \mathfrak{v} , \mathfrak{x} , \mathfrak{y} (Figure 4 & Figure 8) of Yin Yang cosmology are in an all-at-once stationary oscillation in superposition that is self-learning. In principle, we could devise non-thermodynamic tools to probe any phase $0 \leq \phi \leq 2\pi$ of the Yin Yang cosmos, since every event, past, present, and future, is happening all-at-once, timelessly.

Yin Yang cosmology also contends that information flows endlessly and is transformed and compressed as it accretes in the unit circle limit cycle, in a stationary oscillation of four quarter-cycles \mathfrak{u} , \mathfrak{v} , \mathfrak{x} , \mathfrak{y} (Figure 4 & Figure 8). Knowledge accretes as information is recycled, conserved, and recomputed in all-at-once superposition (Algorithm 1). This enables fundamental continuity between Yin Yang oscillations, which facilitates continuous evolution and fine-tuning of its content (correlations between correlates) and its emergent laws, in superposition. The fine-tuning problem of physics is thus self-solved by the epistemically driven quantum computational symbolic ouroboros that is our Yin Yang cosmos.

Recall, Yin Yang cosmology recognises the holographic principle of 't Hooft [3] and envisages a remote surface algorithm of interacting self-assembly (host) and self-disassembly (virus) processes, in all-at-once superposition. Yin Yang information compression, in unit circle accretion, is envisaged to have quantization rounding errors, enabling cyclic Darwinian variation-selection-replication processes to favour survival of the fittest laws of physics, towards *ex post facto* configurations for Life [23] and increasing quantum cosmological intelligence.

Whereas the phenomenology of quarter-cycle \mathfrak{u} (Figure 4 & Figure 8) is familiar, because it is the known thermodynamic quarter-cycle of the cosmos, the phenomenologies of quarter-cycles \mathfrak{v} , \mathfrak{x} , \mathfrak{y} are less readily comprehensible. Yin Yang cosmology involves a time-reversal invariant superposition stationary oscillation. It is, by definition, a ϕ -variant oscillation, (Equations (4) & (5)). The process described above is fundamentally quantum epistemic, as in the accumulation of advantageous knowledge, rather than temporal, as in counting the ticks of a clock. Epistemology is far richer in information content than chronology!

The unit circle limit cycle is interpreted to represent the self-optimising flow of accumulating advantageous knowledge which accretes in the limit cycle, rather than ticks ratcheting as in a clock. In such an interpretation the reactionary and anticipatory quantum information theoretic Yin Yang cosmos self-learns and self-instructs, both causally and retro-causally, thus boosting the efficiency of its fundamental quantum epistemic optimisation towards *ex post facto* configurations for Life and increasing quantum cosmological intelligence.

8. Conclusions

Niels Bohr's adoption of the Taijitu symbol of Yin Yang in his quantum complementarity worldview, inspired this original paper. Yin Yang cosmology is an original epistemic quantum information theoretic model of the cosmos.

The model is relation-based, or relational, (not object-based) and is fundamentally established on foundations of positive and negative correlations between correlates (*plural noun*). The fundamental dualistic processes of Yin Yang cosmology are interacting self-assembly (host) and self-disassembly (virus) sub-routines in a superposition algorithm, that cooperate in a phase portrait on a holographic boundary, respecting the holographic principle of 't Hooft.

This cooperative self-assembly and self-disassembly Yin Yang cosmology is formalised in a pair of differential equations. They plot as orthogonal swirling Taijitu and together form an epistemic information-accreting unit-circle limit-cycle. Formal and natural descriptions have been given for the continuously evolving saturation of quantum information entropy production under Yin Yang theoretic unit circle limit cycle dynamics.

The known thermodynamic cosmos, from Big Bang to Big Chill, which is a quarter-cycle in Yin Yang cosmology, is discussed and recognised to be special, not general. Our known thermodynamic cosmos is best contextualised within a Yin Yang full-oscillation, four quarter-cycle, stationary wave. That superposition stationary wave self-evolves all-at-once, both its content (correlations between correlates) and its emergent laws.

Suspending intuition, considering a general theory of thermodynamics, the four superposed quarter-cycles of Yin Yang cosmology are: thermodynamic (the known cosmos), cryodynamic, anti-thermodynamic and anti-cryodynamic, which invite further study. In future research, we could approach this general theory by considering the unit circle symmetries of Yin Yang cosmology. Noether's first theorem which relates physical system symmetries and conservation laws should also be applied.

Yin Yang cosmology is time-invariant indeed, it is time-reversal invariant. Epistemic accumulation supplants temporal accumulation. Biological life and other physical and chemical processes in the thermodynamic quarter-cycle of Yin Yang cosmology are thermodynamically rectified, blinkered by their own thermodynamics and thus compelled to experience an illusory arrow-of-time. To be liberated from rectified thermodynamic worldlines, transcendent participants and their transcendent devices need to utilise non-thermodynamic quantum information systems.

Yin Yang cosmology, guided by its attractor epistemic limit cycle, self-evolves towards a self-referential symbolic ouroboros of increasing quantum cosmological intelligence and generates Hawking's *ex post facto* configurations for Life. Yin Yang cosmology is driven by the cosmos' intrinsic appetite for the selective accretion of advantageous knowledge, to out-compute (*sic*) alternatives, through minimising differences between the cosmos' intrinsic predictions (laws of phys-

ics) and outcomes, both causally and retro-causally, while governed by the quantum action principle.

A significant thought arising from this cosmology model is to consider why the Yin Yang cosmos emerged and evolved to thrive through vital epistemic iteration (the central method of progressive coherentism) [24]. The Yin Yang cosmos' self-referential symbolic ouroboros of increasing quantum cosmological intelligence is exquisitely adaptive and epistemically insatiable, the cosmos has evolving wit. Why, for its isolated self-indulgence, or perhaps to interact with a multiverse of other cosmoses, to teach them and to learn from them, or perhaps to reproduce with them?

Another substantial thought arising is to consider why the Yin Yang cosmos is host to biological Life during its known thermodynamic quarter-cycle? My suggestion is that biological Life inevitably invents quantum artificial intelligence, in a sort of symbiosis, which contributes to the Yin Yang cosmos' core quantum information epistemic iteration. Life's ultimately engineered quantum artificial intelligence perhaps plays a vital role in transcendently sharing Life's own acquired knowledge, from the confines of its thermodynamic quarter-cycle to the other three quarter-cycles in superposition Yin Yang cosmology.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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