A New Dialogue on Yijing -The Book of Changes in a World of Changes, Instability, Disequilibrium and Turbulence.

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ABSTRACT

This paper proposes a reinterpretation of the Chinese worldview on equilibrium/nonequilibrium and yin-yang. Important terminologies and concepts that constitute Yijing have correlative aspects with irreversible thermodynamics and quantum reality- instability, nonlinearity, nonequilibrium and temporality. Ilya Prigogine is a Nobel laureate noted for his contribution to dissipative structures and their role in thermodynamic systems far from equilibrium, complexity and irreversibility. His expressions, as argued in this paper, resonate with the principles in Yijing. Thus, this paper attempts to re-state existing interpretations of Yijing's ideas with reference to science. Understanding Yijing's terms and concepts must be contextualised to account for its pervasiveness of temporality and the change process. Otherwise, these cardinal concepts may be misconstrued as a hodgepodge of Eastern traditions with no relevance to modern science. This paper concentrates on the fundamental role of indeterminism in nonlinear systems on classical and quantum levels using Yijing's conceptual framework. It concludes that the dominant ideas in Yijing and ancient Chinese philosophy resonate with the current scientific belief – the end of certainty. Instability, far-from-equilibrium, irreversibility, probability, bifurcation, and self-organisation are intrinsic properties of nature appearing at all levels, from particle, protein folding, and DNA double helix to cosmological scales. Information is the basis of all changes, and the agency of change is the human ('ren') with a consciousness existing in the probability space between heaven ('tian') and earth ('di'). Finally, this paper outlines a modelling approach with the self-organising human in the centre between heaven and earth, representing living systems as discrete dynamical systems presented with binary choices (yin-yang). The interplay of yin and yang lines in a hexagram is thought to reflect the changing dynamics of a given situation, and the interpretation of the hexagram is based on the relationships between the yin and yang lines based on informational availability. In this way, the concepts of yin-yang and information causality are central to Yijing's understanding of change and are clarified in this paper.

Keywords

Book of Changes, Yijing, Thermodynamics, Instability, Equilibrium, Disequilibrium, Probability, Wholeness, Implicate-explicate order

INTRODUCTION

The Yijing (or I-Ching), also known as the Book of Changes, is an ancient Chinese classic and philosophical work that reveals the significance of equilibrium, harmony and balance in chaos and uncertainty. In a world of changes, instability, disequilibrium and turbulence, the dynamic creativity of continuous translations and transformations is about operating to bring the systems back to equilibrium. The natural alternation of equilibrium/disequilibrium and stability/instability is created due to a fluctuating energy landscape[1]. "All things that exist, including matter, energy, mind, and spirit, are constituted by qi 氣". [2]

Yijing features the complexity of systems, indeterminism and chaos in the environment but describes a particular order out of chaos through a symbolism represented by the hexagram. The Yijing is based on the concept of yin and yang, representing the universe's complementary and dynamic forces. These forces constantly interact and influence each other, leading to change and development. The Yijing reflects this understanding of the world as a complex system with elements of indeterminism and chaos. Still, it also suggests a fundamental order and coherence underlying this chaos. The 64 hexagrams in the Yijing represent the different patterns and arrangements (of yin and yang) that can be seen in many complex systems in the world. They are used to help interpret the changes and events in one's life and environment. Every complex system comprises many subsystems, and "information flow provides a natural measure for the causal interaction between dynamical events" [3] in the subsystems. In a way, Yijing represents a series of levels of increasing complexities (Figure 1), hierarchically stacked to form the primary eight trigrams.

The Yijing accommodates the complexity theory demonstrating the co-existence and compatibility of unity with diversity, systematic bifurcation of subsystems (illustrated in Figure 1) with hierarchical levels in binomial or exponential progression, nonlinear dynamics and strange attractors, the interdependence and interconnection of parts and the whole, etc.[4]

"The coordination of the relationship between the changing world and the human experience is the main axis of the Yijing".[5] Yijing's depiction of the world as a complex system containing both order

[1] Energy landscape refers to the flow of 气('qi') in an environment. Throughout the world, especially in China, the question of qi is obfuscated and has correlative issue with fengshui; encumbered with an obtuse superstition and charlatanism.
[2] Joseph A. Adler, *The Original Meaning of the Yijing: Commentary on the Scripture of Change* (Columbia University Press, 2020)(p. 29).
[3] X. San Liang, 'The Causal Interaction between Complex Subsystems', *Entropy*, 24.1 (2021, p. 3) <https://doi.org/10.3390/e24010003>.
[4] S. A. Gunaratne, 'A Yijing View of World-System and Democracy.', *Journal of Chinese Philosophy*, 33.2 (2006), 191–211.
[5] Roger T. Ames 安樂哲, 'The Great Commentary (Dazhuan 大傳) and Chinese Natural Cosmology', *International Communication of Chinese Culture*, 2.1 (2015), p. 1 <https://doi.org/10.1007/s40636-015-0013-2>.

and chaos is central to its philosophy. It continues to be a source of inspiration for scientific and philosophical inquiries. 气('Qi') is the vital energy or life force that permeates all things in the universe. It is a concept central to Chinese philosophy, is seen as the source of all change and movement, and has a persistent influence on the Chinese's sensemaking of the world. In Yijing, energy and information are linked through the concept of Qi.

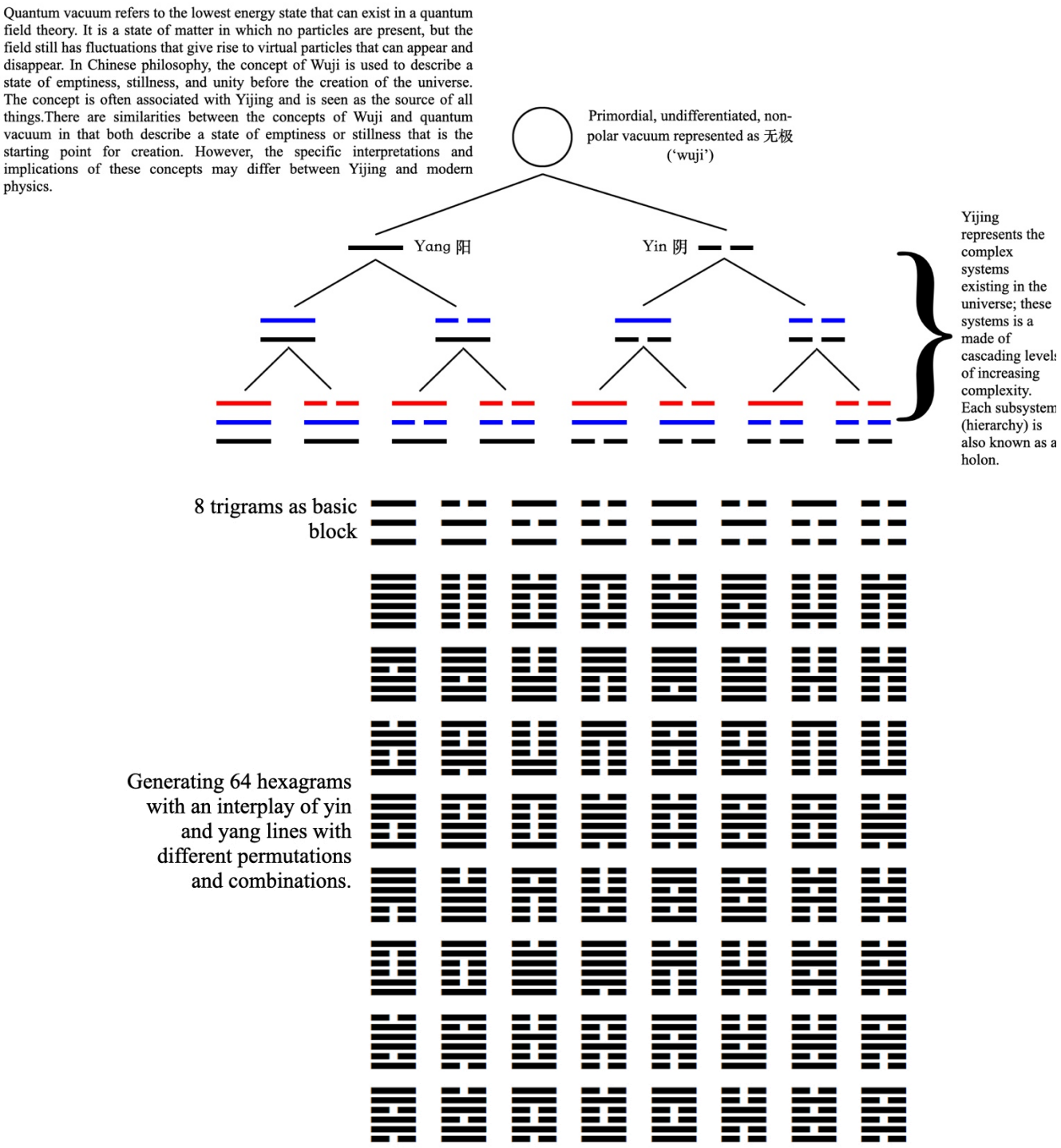

Figure 1, Yin-yang and showing the hierarchical relations in the trigram formation and relationship of the hexagrams

The 64 hexagrams of the Yijing represent different configurations of Qi and the changing patterns of energy in the universe. The system is made of cascading levels of increasing complexity. Each subsystem (hierarchy) is also known as a holon: the "individual in society is a social holon, consisting hierarchically of cells, organs, organ systems, and body and is part of the larger group, culture, and society".[6]

These hexagrams are interpreted as symbols of natural processes and human situations. They provide information about the nature of a particular moment in time and how it relates to the broader pattern of energy and change. The creative tension that arises from Qi in the Yijing framework refers to the dynamic interplay between opposing forces and the potential for growth and transformation from these interactions. The dichotomous yin-yang describes the creative tension between these opposing forces as drivers of change and development and that this creative tension is the source of all creativity and innovation. This paper argues that the Yijing framework explains energy, information, and creative tension as interrelated concepts, with Qi serving as the underlying force that creates and sustains the dynamic interplay between these elements. In the Yijing framework, uncertainty, information, and energy are all interpreted in terms of Qi. It is depicted by "a universal creative principle or force (taiji) that unfolds or evolves into a bipolar state of creative tension, which in turn further differentiates into the multiplicity of the phenomenal world, each particular entity of which is said to contain in full the original creative principle".[7] Uncertainty is seen as a manifestation of Qi, constantly in flux and creating new possibilities. Uncertainty is an inherent aspect of existence, as everything is in constant change and flux. The 64 hexagrams are symbols constructed to represent this uncertainty. Each hexagram provides information about a particular moment in time and how it relates to the broader pattern of energy and change, allowing the reader to gain insight into the nature of the situation and how to respond to it. The hexagrams of the Yijing are seen as symbols of information about the flow of Qi at a particular moment in time. By understanding the Nature of the Qi at a given moment, the Yijing provides information about the situation and how to respond to it. By understanding the Nature of the Qi at a given moment, one can understand the flow of energy, gain insight into the flow of energy and information in the universe, and navigate uncertainty and change more effectively. In the context of Yijing, energy refers to the flow of Qi that drives change and transformation. This paper relates uncertainty, information, and energy as interconnected aspects of life that are shaped and influenced by the underlying force of Qi.

The end of certainty and the view that the world is a mechanical automaton inherited from classical physics [8] give way to the "spectacular growth of nonequilibrium physics and the dynamics of unstable

[6] S. W. Littlejohn and K. A. Foss, *Theories of Human Communication* (Waveland press., 2010).
[7] J. A. Adler, 'On Translating Taiji', *On Translating Taiji. Returning to Zhu Xi: Emerging Patterns within the Supreme Polarity*, 2015, p. 52.
[8] Lars Koopmans and Hyun Youk, 'Predictive Landscapes Hidden beneath Biological Cellular Automata', *Journal of Biological Physics*, 47.4 (2021), 355–69 <https://doi.org/10.1007/s10867-021-09592-7>.

systems, beginning with the idea of chaos" [9]. What is striking in the current discussion is the way Yijing is recast and discussed in the light of science using quantum and complexity science to explain the nonequilibrium environment with entropy and thermodynamics in place of the "Cartesian-Newtonian view of the natural world as a mass of 'dead matter in motion', deriving from the natural-scientific discourse that arose in western Europe during the seventeenth century"[10].

> During the sixteenth and seventeenth centuries, science in Europe developed increasingly beyond the institutional control of either church or state. By contrast, in imperial China, the state's intervention went essentially unchallenged. The result was that, although Chinese scholars produced an enormous amount of useful literature in mathematics, astronomy, and the natural sciences from the mid-sixteenth century through the nineteenth, this new information did not result in any significant political, social, or economic transformations.[11]

The Cartesian-Newtonian deterministic science gave rise to rapid industrialisation by manipulating the natural world with mechanical and engineering precision; and "the enormous efficacy of the Cartesian-Newtonian worldview, especially in having made possible the wonders of modern technology". [12] Ames argued, "our existing formula of terms for translating the core [Chinese] philosophy vocabulary is freighted with a cosmology not its own, and thus perpetuates a pernicious cultural reductionism".[13] Thus, most Western views have a reductionist cultural lens and may not capture the essence of the Chinese's vast cosmological views. The Chinese pursued their scientific investigation of the natural phenomena for millennia without scientific instrumentation in their observation and discussed complexity using the 8 x 8 hexagrams in the Yijing. Yijing is an ancient classic, philosophy, culture and science. It is believed to have originated seven thousand years ago, with three key sages contributing to its texts over four thousand five hundred years (Fuxi, Zhou Wenwang and Confucius)[14] . However, the age of Yijing is still a matter of scholarly debate. This book is a collection of philosophical ideas that deal with dialectic thinking and principles of meteorology, astronomy, and physics. It is also a social treatise that aims to teach people how to interact with others [15] placing a consciously aware individual 'ren' at the centre observing changes (changes in

[9] (Prigogine & Stengers, 1997, p. 3)
[10] (Parkes, 2003, p. 185)
[11] Richard Smith and Shellen Wu, 'Needham and the Yijing', *Inference: International Review of Science*, 6.4 (2022) <https://doi.org/10.37282/991819.22.17>.
[12] (Parkes, 2003, p. 185)
[13] Roger Ames, "Translating Chinese Philosophy," in An Encyclopedia of Translation: Chinese-English, English-Chinese, ed. Chan Sin-wai and David E. Pollard (Hong Kong: The Chinese University Press, 1995). 731. East and West: A Cross-Cultural Approach, ed. Cornellia N. Moore and Lucy Lower (Honolulu: University of Hawaii College of Languages, Linguistics and Literature and the East-West Center, 1992).
[14] (Wang & Chee, 2011)
[15] (Wang & Chee, 2011)

informational state[16] and value[17] leading to the changes in the hexagram also known as 卦 'gua'). "Consciousness plays a key role in this picture of the structure of reality".[18] The Chinese worldview and wisdom are vastly different from Western culture, particularly in the way science is organised to solve practical problems. The Chinese worldview is about using "dialectical and holistic thinking modes and applying intuitive comprehension" [19] with the economisation of words. The Chinese language and cultural worldview have a tendency towards conciseness and economy of words. This is reflected in many aspects of Chinese culture, including literature, where prose is highly valued, and poems and songs often express their messages in compact and symbolic language. This economy of words is considered a hallmark of Chinese literature. It is seen as a reflection of the practical and straightforward Nature of Chinese culture for self-reflection, decision-making and philosophical inquiry.

The Yijing is a system of divination and philosophy, whereas modern science is a systematic and empirical method of acquiring knowledge about the natural world. The Yijing relies on interpretation and intuition, while science relies on observation, experimentation, and verification. Yijing's approach to understanding the world is based on ancient Chinese philosophy and cosmology, while science is based on a more recent and continually evolving body of knowledge. "The Yijing as a text is itself an object lesson in the worldview that it attempts to present. That is, when we reflect on the nature of particular "events" within this process worldview, the relationship between these particular foci and their fields lends itself to a holographic understanding of world systems"[20] The Yijing and science are fundamentally different in their methodologies, goals, and assumptions. However, as Needham revealed, there is very little in the natural world that Yijing symbolism does not represent or explain. Needham explored the use of the Yijing as a symbolic system for understanding the natural and social world and how this understanding influenced the development of Chinese science, philosophy, and religion. He argued that Yijing played a central role in shaping Chinese thought and was deeply integrated into many aspects of Chinese culture, including medicine, divination, and political theory. According to Needham, Yijing's use as a symbolic system reflected a holistic view of the world in which the natural and social were seen as interconnected and in which the cycles and patterns of nature were used as a model for understanding the relationships between people and their environment.

> The terrain covered by the *Changes* included not only the fields we now know as mathematics, biology, chemistry, physics, and medicine but also other areas of scientific

[16] Informational state refers to the level of information gathered at each point (from the preceding state to the current state).
[17] Information value, in the context, measures information usefulness. Information's ultimate value depends on its use, leverage and application. 'Ren' discovers, creates and innovates around information assets in a probabilistic way. Individuals must therefore be conscious and aware of the information and corresponding changes.

[18] (Schöter, 2011, p. 417)
[19] (Wang et al., 2022, p. 8032)
[20] Ames (2015, p. 2).

> knowledge such as geography, topography, and cartography. The color and flow of blood, the anatomy of crustaceans, the physical constitution of people from different areas of China, acupuncture and pulse points, chemical and alchemical reactions, the nature of earthquakes, musical tonality, and a great deal more were all explained by reference to trigrams, hexagrams, or both [21].

Classical science features order and stability in contrast to fluctuation and instability[22] since change is a pervasive and persistent notion in Yijing. These initial conflicting viewpoints between classical science and quantum or complexity science are stark but are harmoniously explained in the Yijing framework using an energy (qi) concept existing in a probability space between heaven ('tian') and earth ('di')[23] examined energy(-like) 'landscapes' for complex living systems. "Energy landscapes summarize all possible dynamics of some physical systems. Energy(-like) landscapes can explain some biomolecular processes, including gene expression and, as Frauenfelder[24] showed, protein folding[25]" [26].

This paper begins with a literature review of physics and metaphysics, drawing the overlapping explanations of quantum science, thermodynamics and complexity science with reference to the Yijing framework (since their contribution to modern science is underexplored in extant literature). Then, from ancient texts in 系辞('Cixi'), this paper provides comparative side-by-side explanations and insights into what quantum science and complexity science have discovered (See Table 1) and how Yijing lies at the basis of all Chinese perspectives of science. It is necessary to emphasise that the comparison aspects demonstrate Chinese yin-yang dichotomous views and the five-element cycle[27] with Qi flux,

[21] (Smith & Wu, 2022).
[22] I. Prigogine, *Is Future Given?* (World Scientific, 2003).
[23] Koopmans and Youk (2021)
[24] Frauenfelder popularised the idea of energy landscapes in the interactions and motion of protein. In Frauenfelder et al. (1991) advanced the idea that protein dynamics are complex and can be observed and understood from an energy landscape. "Where the dynamics of biomolecules goes far beyond similar problems in physical systems is the connection between dynamics and function and between dynamics and evolution. Evolution occurs through changes in the primary sequence of the proteins, which leads to changes in the structure and the conformational energy landscape. Because of the diversity of the conformational substates, one can see mutations as acting to change some substates more than others. If there is selection pressure, it may be useful to dig a few deeper wells that are more separated than most from the near-continuum of energy states" (Frauenfelder et al., 1991, p. 1602).
[25] Protein folding is a delicate process where a newly synthesized chain of amino acids transform itself into a perfectly folded protein depends on the intrinsic properties of the amino-acid sequence" (Dobson, 2003, p. 884)
[26] Koopmans & Youk (2021, p. 355)
[27] The five elements that are used to explain the dynamic relationships between different aspects of the universe. These five elements are:
Wood: Wood is associated with growth, expansion, and creativity. It is believed to symbolize the beginning of a cycle, where new ideas and projects take root and start to grow.
Fire: Fire is associated with energy, passion, and enthusiasm. It represents the peak of the cycle, where everything is in full bloom and at its most intense.
Earth: Earth is associated with stability, grounding, and nourishment. It symbolizes the time when the cycle is beginning to slow down and consolidate.

which form the overarching ideology and knowledge structure. The synthesis of these principles develops a philosophy of naturalism and Chinese proto-scientific thinking. The later section clarifies the connections and common threads.

> The Chinese worldview depended upon a totally different line of thought. The harmonious cooperation of all beings arose, not from the orders of a superior authority external to themselves, but from the fact that they were all parts in a hierarchy of wholes forming a cosmic pattern, and what they obeyed were the internal dictates of their own natures. Modern science and the philosophy of organism, with its integrative levels, have come back to this wisdom, fortified by new understanding of cosmic, biological and social evolution. [28]

Yijing is vast with far-ranging and embracive coverage and has everything complete within it. It contains the way of the heavens, the way of human beings, and the way of the earth.[29]

LITERATURE REVIEW

Physics and metaphysics

The world, as immediately experienced in physics and metaphysics, is different.

> The Yijing is a complex text that includes both a manual used as heuristic for making correlations, and seven appended commentaries. Since three of these commentaries are divided into two sections each, in sum they are often referred to as the "Ten Wings." The manual, used traditionally as an instrument for pursuing productive correlations, is of a much earlier vintage than the commentaries, and has come to be referred to independently as the Zhouyi 周易. Although the commentaries are themselves composite and sometimes fragmentary, and certainly belong to a much later period than the manual itself, portions of them are hugely important as a summary statement of an early Chinese cosmology that has had a persisting influence on the Chinese sense of its world.[30]

For over 2000 years, Yijing provides "one of the most important statements in the Chinese tradition on knowing how the cosmos works and how humans might relate to that working. Especially from the Sung [Song] through the Ch'ing [Qing] periods, the 'Great Commentary' ('Ta chuan [Dazhuan]'), as it

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Metal: Metal is associated with refinement, discipline, and organization. It represents the time when the cycle is ending, and the focus is on gathering and preserving the fruits of the previous cycle.
Water: Water is associated with flexibility, adaptability, and flow. It symbolizes the time when the cycle is in a state of transition, moving from one phase to the next.
Each of these five elements is believed to have a unique character and influence, and they are often used in combination to explain the various relationships between different aspects of the universe.

[28] Needham (1956, p. 582)
[29] Ames (2015, p. 3).
[30] Ames (2015, p. 2).

was called, provided the locus classicus for vocabulary and concepts in nearly every major abstract discussion of the physical world and man's place in it"[31]. Whitehead argued that "weakness of insight and deficiencies of language stand in the way inexorably. Words and phrases must be stretched towards a generality foreign to their ordinary usage; and however, such elements of language be stabilized as technicalities, they remain metaphors mutely appealing for an imaginative leap".[32] Yijing survives at least two millennia with its symbolic and analogical representations through the hexagrams, mutely appealing to the Chinese imaginative leap involving cultural fusion and their unique worldview.[33]

Whereas, for physics before the Copenhagen Interpretation, Newtonian science dominated. Newton's laws are entirely deterministic, which imply that anything that happens at any future time is completed determined by what happens now, and everything now was wholly determined by what happened at any time in the past. The law of classical physics is constructed such that if the variables in a closed system are provided at some initial condition at a point in time, they can be calculated with mechanical precision for any other instant. This determinism influences science in the industrialisation era and is an essential part of scientific philosophy.[34]

Due to the pressures of new scientific discoveries, modern physics has abandoned its traditional determinism. Instead, it has adopted a new approach known as quantum mechanics. This new theory allows for statistical statements regarding the behaviour of mass particles.

> Planck himself was always sceptical towards the statistical interpretation of quantum mechanics. The same is true of Einstein; even today he continues to point out, by means of ingenious examples, contradictions in this interpretation (and he is, moreover, still more concerned with the resolution of the concept of physical reality, which is closely involved with the problem of determinism).
>
> Schrodinger goes still further; he proposes to abandon the concept of particles (electrons, nuclei, atoms, etc.) and to construct the whole of physics upon the idea of waves, which obey deterministic laws in accordance with wave mechanics. De Broglie (and others) take the opposite course; they reject waves, and seek a reinterpretation of quantum mechanics, in which everything is in principle determinate, and an uncertainty in prediction arises only by the presence of concealed and unobservable parameters.[35]

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[31] Willard J. Peterson, 'Making Connections: "Commentary on The Attached Verbalizations" of The Book of Change', *Harvard Journal of Asiatic Studies*, 42.1 (1982), 67 <https://doi.org/10.2307/2719121>.
[32] Alfred North Whitehead, 'Process and Reality : An Essay in Cosmology; Gifford Lectures Delivered in the University of Edinburgh during the Session 1927-28', 1929, p. 4.
[33] Dong Guangbi, 'Studies of The Book of Changes (Yi Jing) and Twenty-First-Century Science', *Contemporary Chinese Thought*, 39.3 (2008), 10–22 <https://doi.org/10.2753/CSP1097-1467390301>.
[34] Max Born, 'Is Classical Mechanics in Fact Deterministic?', 1969, pp. 78–83 <https://doi.org/10.1007/978-3-662-25189-8_7>.
[35] Born (1969, p. 78).

This paper also attempts to use Bohm's wholeness and implicate order[36] to discuss order/stability and fluctuation/instability. Bohm developed a quantum mechanics interpretation that is highly non-local, where everything in the universe affects everything else. Bohm coined the term 'holomovement' to describe the flow of quantum reality. He believed that everything in the universe is interconnected and constantly in flux and that this flow can be understood as a single, unbroken process. This movement is non-local, meaning that events occurring in one part of the universe can instantaneously affect another part. Bohm proposed that the seemingly separate physical objects in the world are projections of a deeper, underlying implicate order and that the holomovement is the process by which this implicate order unfolds into the manifest world of experience. The implicate and explicate orders in Bohm's theory are related to information in the sense that the implicate order is seen as the source of information that gives rise to the explicate order. According to Bohm, the implicate order is the underlying reality that contains all the information about the universe's structure, "enfolded" within it in a non-local manner. This information is then "unfolded" into the explicate order, which is the physical reality experienced through the senses and instruments. In this sense, the explicate order can be seen as a manifestation of the information stored in the implicate order. The two orders are interconnected, with the explicate order influencing the implicate order and vice versa, in a continuous feedback loop. In this way, Bohm's theory emphasizes the interconnectedness and interdependence of all things in the universe. Schoter's "The Yijing: Metaphysics and Physics" explored the connection between ancient Chinese divination and modern physics.[37] Schoter argued that the Yijing contains principles that are similar to those found in modern physics, particularly in the way trigrams are organised to form the hexagrams, and further explained that 乾(Heaven, 'qian') is a pure-yang hexagram representing the creative source, implicating information (through enfoldment) and generating the emergence events while 坤 (Earth, 'kun') is a pure-yin hexagram representing the receptiveness where the earth provides the material substrate and space for the creative to explicate into forms and physical reality to be experienced through the senses.

[36] Bohm's (2002)
[37] Schöter (2011).

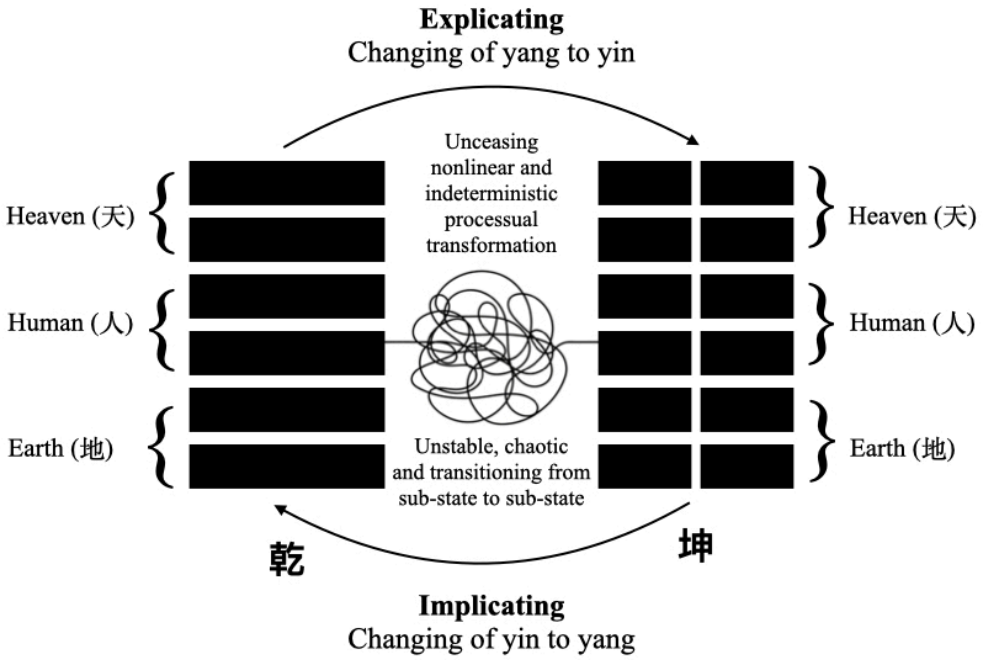

Figure 2, illustrates hexagrams transformation using Bohm's implicate/explicate orders

Schoter's suggested a parallel between Bohm's implicated/explicated reality and Yijing hexagram representation based on the traditional realms of heaven ('tian'), earth ('di') and human ('ren')[38] (illustrated in Figure 2). Schoter cited Dazhuan[39]

In the heavens images are completed.
On the earth bodies are formed. ...
Qian knows the great beginnings.
Kun makes and finishes things.

> The trigram associated with heaven is qian, the Creative; this is pure yang, the source of all movement, and generates the patterns which events follow. In contrast, the trigram associated with earth is kun, the Receptive, pure yin; this provides a material substrate in which the unfolding of the Creative patterns can actually take form. The parallels between the implicate order as tian and the explicate order as di are clear. Further, in the traditional metaphysics Humanity, ren, arises between, and serves to connect, Heaven and Earth, which is exactly how consciousness functions in Bohm's picture, connecting the implicate and the explicate.[40]

[38] Schöter (2011).
[39] Schöter extracted a quote from Dazhuan which is a translation from Wu Ying-nuan, Yi Jing (Washington, DC:The Taoist Center, 1991), 263
[40] Schöter (2011, p. 417)

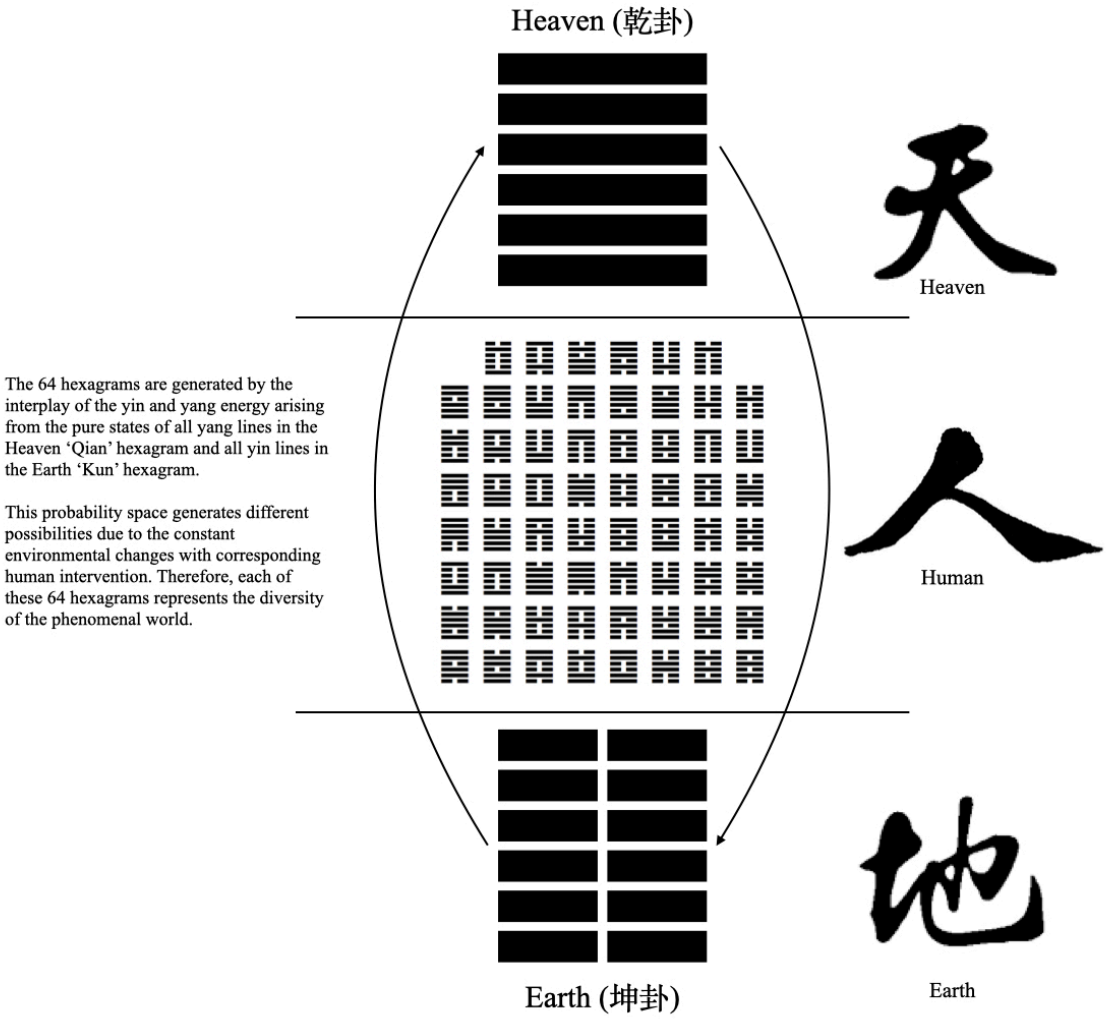

Figure 3, illustrates the flux change and transformation between heaven and earth

The heavens and the earth are in flux and undergo transformation (illustrated in Figure 3). The human experience, physically and conceptually, resides between heaven and earth, subject to the manifold change processes. The manifestation of flux and transformation is such that "images [information] are brought about in the heaven and forms are brought about on earth, in which fluctuation and transformation are seen"[41].

[41] Adler, J.A., "Zhu Xi's Commentary on the Xicizhuan (Treatise on the Appended Remarks) Appendix of the Yijing (Scripture of Change)" (2017), A1, p.10

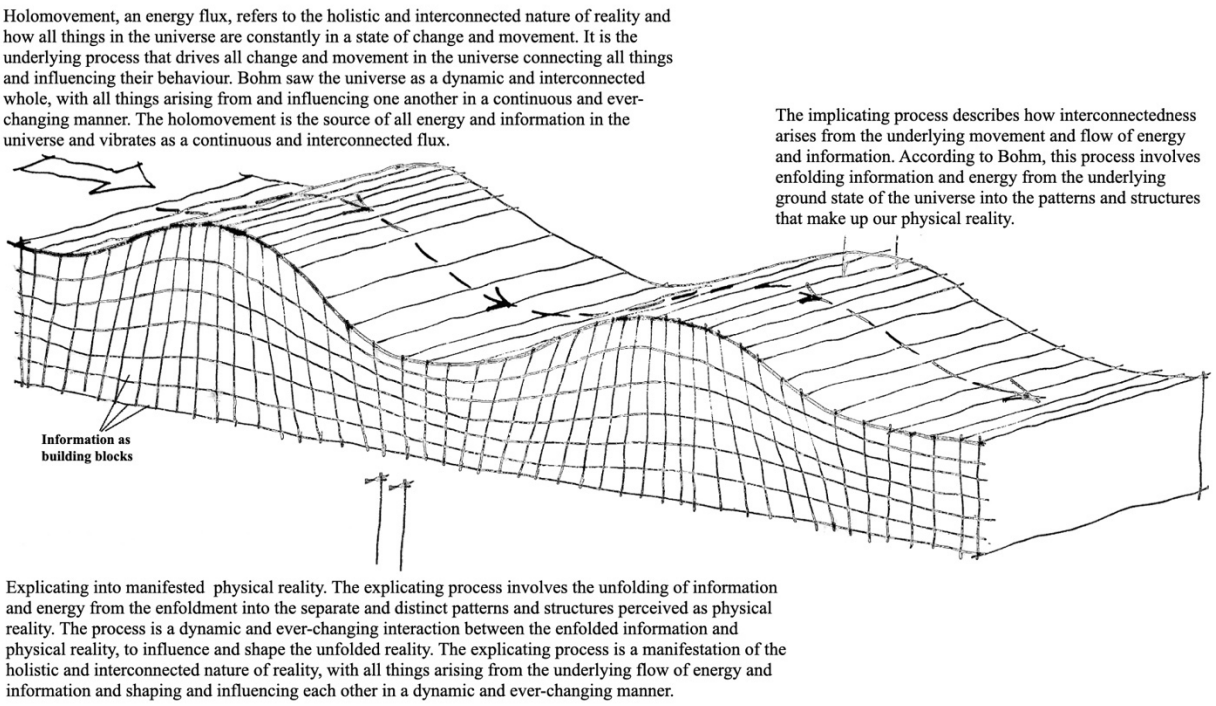

Figure 4, illustrates the holomovement as a flux

Commentary using Adler's[42] [43] translation of Zhu Xi's Commentary on 系辞传 Xicizhuan and other references	Scientific contexts, equivalents, principles and examples
Images are brought about in heaven and forms are brought about on earth, in which fluctuation and transformation (bianhua 变化) are seen (A1: p. 10). Therefore what is above form (xing'er shang 形而上) is called the way; what is within the form (xing'er xia 形而下) is called implements. Transforming and regulating is called fluctuation (bian 变); extending and proceeding is called continuity (tong 通)[44]	The Bohmian Implicate/Explicate Order is a concept developed by the physicist David Bohm[45]. According to Bohm, the universe has two fundamental aspects: the implicate order [*here, interpreted as heaven*] and the explicate order [*interpreted as earth*]. The implicate order is a deeper, underlying reality level that contains all the information and relationships enfolded within it. This level of reality is seen as being non-manifest and non-physical, yet it is said to underlie and give rise to the physical world. Bohm described this reality level as a hologram in which each part contains information about the whole. On the other hand, the explicate order is the manifest physical world that we see around us. This reality level is seen as the result of unfolding the information and

[42] Joseph A. Adler, 'Zhu Xi's Commentary on the Xicizhuan 繫辭傳 (Treatise on the Appended Remarks) Appendix of the Yijing 易經 (Scripture of Change)- Part A', 2017 <https://www2.kenyon.edu/Depts/Religion/Fac/Adler/Writings/Xici trans A.pdf>.
[43] Joseph A. Adler, 'Zhu Xi's Commentary on the Xicizhuan 繫辭傳 (Treatise on the Appended Remarks) Appendix of the Yijing 易經 (Scripture of Change)- Part B' <https://www2.kenyon.edu/Depts/Religion/Fac/Adler/Writings/Xici trans B.pdf>.
[44] Joseph A. Adler, 'Zhu Xi's Commentary on the Xicizhuan 繫辭傳 (Treatise on the Appended Remarks) Appendix of the Yijing 易經 (Scripture of Change)- Part A' p. 42
[45] Bohm.

	relationships within the implicate order. Bohm called this process the "holomovement." The holomovement refers to the process by which the information and relationships contained within the implicate order are enfolded into the physical world and manifest as the explicate order. This movement is said to be continuous and ongoing [*transforming and regulating is called fluctuation, extending and proceeding is called continuity*], and it gives rise to the dynamic and changing nature of the physical world. In this view, reality can be understood as a dynamic, interconnected whole, with the implicate order and the explicate order being two complementary aspects of this unity. Bohm's concept of the implicate/explicate order provides a way of understanding the underlying interconnectedness of the universe and the relationship between the physical and non-physical aspects of reality.
The Way of Qian brings about the male; the way of Kun brings about the female. (A4: p. 11) The alternation of yin and yang is called the way[46].	Quantum Field Theory (QFT) is a theoretical framework for understanding the behaviour of particles and fields in the quantum realm. According to QFT, all particles and fields, including light and matter fields, are described by quantum fields that exist throughout space and time. These fields are constantly fluctuating [described in Yijing as continuous change, and their fluctuations give rise to the appearance and disappearance of particles, such as photons and massive particles[47]. [*Here, the appearance and disappearance of particles refer to the transitory state of the hexagrams, appearing and transforming from sub-state (hexagram) to sub-state (hexagram). The firm and yielding [lines] displace each other, giving rise to fluctuation and transformation[48]. The yin and yang hexagram lines alternately displace one another: yin may fluctuate into yang, and yang may transform into the yin.*] One of the critical insights of QFT is that seemingly empty space is not actually empty but instead is filled with fluctuations of light and matter fields. These fluctuations lead to a continuous process of particle creation and annihilation, where particles pop into existence and disappear, resulting in a continuous exchange of energy between the fields and particles[49]. [*The idea of particles appearing and disappearing through fluctuations of fields is often compared to the ancient Chinese concept of yin and yang, which describe reality's complementary and interconnected nature. In the same way that yin and yang represent the cyclical*

[46] Joseph A. Adler, 'Zhu Xi's Commentary on the Xicizhuan 繫辭傳 (Treatise on the Appended Remarks) Appendix of the Yijing 易經 (Scripture of Change)- Part A' p. 18.
[47] S. Weinberg, "The Quantum Theory of Fields, Vol. 1: Foundations," Cambridge University Press, Cambridge, UK (1995).
[48] Joseph A. Adler, 'Zhu Xi's Commentary on the Xicizhuan 繫辭傳 (Treatise on the Appended Remarks) Appendix of the Yijing 易經 (Scripture of Change)- Part A' p. 13.
[49] A. Zee, "Quantum Field Theory in a Nutshell," Princeton University Press, Princeton, NJ (2010).

	nature of life and the interplay between light and dark, the appearance and disappearance of particles in QFT can be seen as a manifestation of the continuous and dynamic balance between the fields and particles in the universe. *Thus, the insights of QFT have shown that seemingly empty space is actually filled with a rich and dynamic interplay of fields and particles and that the apparent emptiness of space is only an illusion.*]

Table 1, juxtaposes Yijing commentary with relevant scientific equivalents, principles and examples.

The phenomenal world is an endless flow characterized by transformation from one sub-state (hexagram) to another. "Things are in fact a processive and hence always provisional flux of "events," where the shifting dispositioning of these events is interactive and mutually shaping"[50]. The provisional flux of events is illustrated in Figure 4 as holomovement[51]. The holomovement refers to the ongoing process of unfoldment and enfoldment in the universe, which is seen as a fundamental aspect of reality. According to Bohm, holomovement is a continuous flow of information and relationships between the implicate and explicate orders of reality. The implicate order is a deeper, underlying reality level that contains all the information and relationships enfolded within it.

On the other hand, the explicate order is the manifest physical world that we see around us. It is seen as the result of unfolding the information and relationships within the implicate order. The holomovement is seen as the dynamic process by which the information and relationships within the implicate order are enfolded into the physical world and manifest as the explicate order. This movement is said to be continuous and ongoing, which gives rise to the changing and evolving nature of the physical world. In this view, reality can be understood as a dynamic and interconnected whole, with the implicate and explicate orders being two complementary aspects of this unity. The holomovement provides a way of understanding the underlying interconnectedness of the universe and the relationship between the physical and non-physical aspects of reality.

In Yijing, the hexagrams represent the explicate order of reality, while the change lines that make up the hexagrams represent the implicate order. The change lines indicate the continuous process of change and the interconnectedness of all things, suggesting that everything is in a constant state of flux and interconnectedness.

Schoter also argued that the Yijing could be seen as a representation of the idea of wholeness, as the hexagrams are not simply a collection of individual lines but are instead a holistic system that can only be understood as a whole. The Yijing teaches us that everything is interconnected and that change is a continuous process, which aligns with Bohm's idea of wholeness and the implicate and explicate orders.

[50] Ames (2015, p. 9).
[51] D. Bohm, *Wholeness and the Implicate Order*, *Routledge*, 1980 <https://doi.org/10.1093/bjps/32.3.303>.

In conclusion, the concept of Bohm's wholeness, implicate and explicate order, and Schoter's interpretation of the Yijing offer a holistic view of reality that is in line with the ancient Chinese philosophy that the Yijing embodies. By understanding the interconnectedness of all things and recognizing the continuous process of change, we can gain a deeper appreciation of the holistic nature of reality and the importance of seeing the world as a whole and as an open system where there are constant transactions, sensing deviations and tensions and taking in energy-matter-information from its environment to equilibrate from a far-from-equilibrium state. "Theoretically, an open/living system cannot reach near-equilibrium or equilibrium (i.e., the point of near-maximum or maximum entropy [heat death]) because its trajectory is determined by a far-from-equilibrium attractor[52] in every phase space".[53]

DISCUSSION

Yijing discusses changes in chaos and explains the order in disorder through the hexagrams (with the commentary).[54] The oracular commentaries (卦辭 'guaci' and 爻辭 "'yaoci') provide deeper insights into the meaning of each hexagram and how it relates to the world and human experience. It offers interpretations of the individual lines within each hexagram and their combined significance, as well as suggestions for appropriate action and behaviour in response to the hexagram's meaning. The Yijing commentary is an integral part of the text and is considered just as important as the hexagrams. It provides a rich tradition of interpretation and offers a wealth of wisdom on living in harmony (in a state of equilibrium and balance) with the natural forces of the universe and navigating change in a meaningful and productive way.

> The rest of what we know as the Yijing consists of a collection of appendixes traditionally called the Ten Wings (shiyi 十翼), although there are actually only seven of them (three are each divided into two parts that are counted separately). They were traditionally

[52] A far-from-equilibrium attractor is a type of attractor in non-equilibrium systems that arise when a system is driven away from thermodynamic equilibrium. In thermodynamic equilibrium, a system has reached a state of maximum entropy, meaning that there is no net flow of energy or matter. In contrast, far-from-equilibrium systems are characterized by a continuous flow of energy and matter, and exhibit complex, self-organized behavior that cannot be explained by simple equilibrium principles. Examples of far-from-equilibrium systems include living organisms, ecosystems, and economic systems. In such systems, the complex behavior that arises is often the result of the interplay between multiple interacting components, and can be difficult to predict or control. Far-from-equilibrium attractors are important in the study of complex systems because they help to explain how such systems can exhibit order and structure despite being driven away from thermodynamic equilibrium. These attractors provide a way to describe the long-term behavior of a system, and to understand how different initial conditions and external perturbations can influence its evolution over time.
Overall, the concept of far-from-equilibrium attractors is an important tool for understanding and describing the behavior of complex, non-equilibrium systems, and for predicting how such systems will evolve over time.
[53] Shelton A. Gunaratne, 'Understanding Systems Theory: Transition from Equilibrium to Entropy', *Asian Journal of Communication*, 18.3 (2008), 175–92 <https://doi.org/10.1080/01292980802207033> (p. 181).
[54] Ames.

> attributed to Confucius (Kong Qiu 孔丘 or Kongzi 孔子, 551- 479 BCE), based on the Han- dynasty historian Sima Qian's statement in the Shiji 史記 (Historical records [ca. 100 BCE])[55]

This paper uses complexity science and nonequilibrium systems to discuss Yijing's change.

The concept of nonequilibrium systems can be related to the changes described in the Yijing in the following ways:

1. Understanding Change: The Yijing is based on the idea that everything is constantly changing and that understanding and navigating change is a critical aspect of human life. This idea is closely related to nonequilibrium systems, characterized by a continuous flow of energy and matter.
2. Dynamic Equilibrium: The Yijing suggests that while change may appear chaotic or unpredictable, it is actually the result of underlying patterns and forces that maintain a dynamic balance. This idea is similar to the concept of far-from-equilibrium attractors in nonequilibrium systems, which describe how complex, self-organized behaviour can arise in systems driven away from thermodynamic equilibrium.
3. The interplay of Forces: The Yijing commentary often describes how different forces and factors interact to produce change and how these interactions can be challenging to predict or control. This idea is similar to the interplay of multiple interacting components in nonequilibrium systems, which can lead to complex, self-organized behaviour.
4. Finding Order in Disorderliness: The Yijing suggests that, despite the appearance of chaos or disorderliness, there is a hidden order and structure to the universe. This idea is related to order emerging from disorder in nonequilibrium systems, where complex behaviour can arise from the interplay of multiple interacting components.

In summary, the idea of change and navigating change described in the Yijing is closely related to the concept of nonequilibrium systems, which describe how complex, self-organized behaviour can arise in systems driven away from thermodynamic equilibrium. The Yijing suggests that despite the appearance of chaos or disorderliness, there is a hidden order and structure to the universe, which is related to the idea of order emerging from disorder in nonequilibrium systems.

> A system can be either closed/isolated or open. Closed systems, which are mostly physical systems isolated from their environment, go through progressive internal chaos (or entropy), disintegration, and death. Open systems, which are biological, psychological, and

[55] Joseph A. Adler, *The Original Meaning of the Yijing: Commentary on the Scripture of Change* (Columbia University Press, 2020)(p. 6).

> social systems, exchange energy/matter and information with their environment. New (or second-wave) systems approaches presume that all living systems are structurally and cognitively open but operationally closed to their environment. Additionally, systems can be identified as conceptual, concrete, abstracted, regulated, totipotential (self-sufficient), autopoietic (self-reproducing), or hierarchical.[56]

How do chaos and disorderliness come to order in nature, and how are equilibrium and disequilibrium treated in Yijing? "In thermodynamics, equilibrium meant maximum entropy (spent energy or disorder) in a closed system. The second law, which asserts that the universe's energy is constant while the universe's entropy is increasing to a maximum, would interpret such a system to have undergone heat death[57]".[58] In thermodynamics, entropy measures the amount of disorder or randomness in a system. It represents the tendency of a system to move towards a state of maximum entropy, which is characterized by maximum randomness and lack of structure (Figure 5 illustrates the morphing of the 乾 Qian hexagram to a 坤 Kun hexagram in the process of moving towards a state of maximum entropy characterized by maximum randomness and lack of structure).[59]

In summary, the relationship between energy conservation and entropic effects is that while the total amount of energy in a system is conserved, the distribution of energy can change over time as some of it becomes unavailable for work and contributes to the disorder or randomness of the system. This is described by the second law of thermodynamics and is an essential aspect of studying thermodynamics. While Yijing and entropy deal with different aspects of change, both concepts can be seen as representing the idea that change is an inevitable part of the natural world and that it is essential for individuals and society to be prepared for and respond to a change in appropriate ways. Using the 蠱 gu hexagram as an illustration to describe the gradual collapse to ruin:

> "Gu: Supreme success": all under heaven is ordered. "Appropriate to cross a great river": going on, there will be things to do. "Three days before the first, three days after the first": after an ending there is a beginning; this is the course of Heaven [Nature]. Explaining the hexagram statement. Ordering what has been ruined leads to

[56] Gunaratne (2008, p. 176).

[57] Heat death is a concept in physics and cosmology that refers to the eventual state of the universe in which all matter is evenly distributed and there is no more energy available for transfer between objects. In such a state, no more work can be done, and the universe has reached maximum entropy. The heat death scenario is based on the laws of thermodynamics and the fact that energy naturally moves from hotter objects to colder ones. Over time, this means that the temperature of all objects in the universe will eventually become equal and no more energy will be available to do work. This state of thermal equilibrium is what is referred to as the heat death of the universe.

[58] Gunaratne (2008, p. 178).

[59] J. Smith, 'Energy Conservation and the First Law of Thermodynamics', *Journal of Physical Science*, 23.4 (2010), 56–62.

> "supreme success" [penetrating]: the image of disorder being put back in order. The end of disorder and the beginning of order is how heaven revolves.[60]

In this sense, the Yijing and entropy can be seen as offering complementary perspectives on change and its effects.

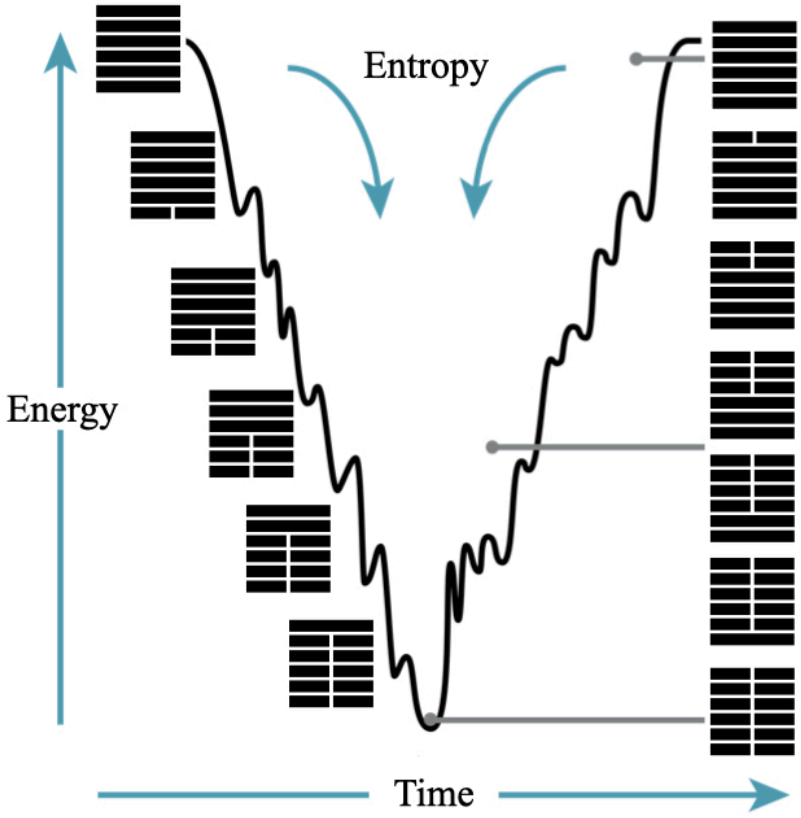

Figure 5 illustrates hexagram changes in relation to energy transfer and entropy.
Illustration credits (Dill & MacCallum, 2012)

Thermodynamics, Entropy and Disorderliness

Ilya Prigogine was a Belgian physical chemist and Nobel Prize winner known for his work on the theory of nonequilibrium thermodynamics. Prigogine, Ilya, Isabelle Stengers, and Heinz R. Pagels[61] explored the idea that systems far from equilibrium can exhibit spontaneous self-organization and the emergence of new structures; and argued that this spontaneous self-organization could lead to the formation of complex structures that are not predictable from the behaviour of the individual components of the system. Complex systems can exhibit order and structure even with random fluctuations and instability. The disorder occurs when the system operates at a distance from equilibrium (or in a far-from-equilibrium state).

Also, the concept of equilibrium and disequilibrium is central to Prigogine's theory. Equilibrium is a state in which a system is at rest, and its properties do not change over time. A balanced and

[60] Joseph A. Adler, *The Original Meaning of the Yijing: Commentary on the Scripture of Change (p.124).*
[61] Prigogine et al. (1985)

equilibrated hexagram is one in which the lines in the hexagram are equally divided between yin and yang, with three yin lines and three yang lines. This represents a state of balance and harmony in the situation being considered and suggests that the forces of yin and yang align and work together effectively. Disequilibrium is a state in which a system is not resting, and its properties change. Prigogine, Stengers and Pagels [62] argued that the key to understanding complex systems is to focus on the interplay between equilibrium and disequilibrium. An imbalanced hexagram, or a hexagram in disequilibrium, is one in which there is an unequal distribution of yin and yang lines, with either more yin or yang lines. This represents a state of imbalance or disharmony in the situation being considered and suggests that the forces of yin and yang are not in alignment or working effectively together. For example, suppose a hexagram has four yin lines and two yang lines; in that case, this suggests an excess of yin energy and a deficiency of yang energy, which can manifest as feelings of passiveness, indecision, or inwardness.

Conversely, suppose a hexagram has four yang lines and two yin lines; in that case, this suggests an excess of yang energy and a deficiency of yin energy, which can manifest as feelings of over-activity or impulsiveness. In general, an imbalanced hexagram in Yijing can indicate a need to change or restore balance and harmony to the situation being considered. The specific nature of the imbalance and the suggested course of action can vary depending on the individual lines and the relationships between them.

In the context of the Yijing, the hexagrams can be seen as a representation of the possible states of a system, and the relationships between yin and yang lines reflect the probabilities of different states. Yijing's approach to divination is based on the idea that the relationships between yin and yang lines can change over time, reflecting the dynamic interplay between equilibrium and disequilibrium. Prigogine's theory of nonequilibrium thermodynamics and Yijing's approach to divination are both based on the idea that complex systems can exhibit order and structure even in the presence of random fluctuations and instability. Yijing and Prigogine's theory highlight the importance of focusing on the interplay between equilibrium and disequilibrium in understanding complex systems. The similarities between Yijing and Prigogine's theory provide a valuable framework for understanding the relationships between change, order, and structure and how these relationships influence our lives and the world around us. Prigogine's work on nonequilibrium thermodynamics can be applied to Yijing in several ways. Spontaneous self-organization can be seen as a metaphor for the unpredictable changes in the relationships between yin and yang lines in the hexagrams. The emergence of new structures can also be seen as a representation of the formation of new hexagrams as the relationships between yin and yang lines change over time.

In Yijing, equilibrium and disequilibrium are represented by the balance between yin and yang lines. When the hexagrams are in equilibrium, the yin and yang lines are balanced, and their relationships are

[62] Prigogine et al. (1985)

stable. However, when the hexagrams are disequilibrium, the balance between yin and yang lines is disrupted, and the relationships between them are unstable.

Prigogine[63] also advanced concepts like 'dissipative structures' and 'self-organization' operating at a distance from equilibrium. Therefore, the arrow of time plays an essential role in these irreversible processes generating various states of matter in succession. Here, the human (exercises free-will action) is the dissipative structure operating in a nonequilibrium environment between heaven and earth (refer to Figures 2 and 3). In nonequilibrium physics and chemistry, when the distance from equilibrium is modulated (fluctuations appear), the observed behaviour varies in response to the fluctuation. In the case of an oscillatory or unstable system (here, explained as the uneven spread of yin and yang in the hexagram), it is "conjectured that in such systems, the departure from the steady state is governed by large fluctuations of macroscopic size" and generally nonequilibrium instabilities are a result of phase transitions.[64] The sixty-four hexagrams represent the phase transitions, and three hundred and eighty-four lines (64 hexagrams x 6 lines) "are the means by which to comply with the principle of human nature and the endowment [ming 命], and to complete the way of fluctuation and transformation [bianhua 變化]. Dispersed among patterns, [the way of transformation] is the myriad things".[65]

> Heaven is honourable [zun 尊], earth is lowly [bei 卑]; thus are Qian and Kun determined. The lowly and high [gao 高] being set out, the honoured [gui 貴] and humble [jian 賤] are positioned. Activity and stillness are constant, determining the firm and yielding [lines]. Tendencies [fang 方] cluster in categories and things are distinguished in groups, giving rise to auspicious and ominous [prognostications]. Images come about in heaven and forms come about on earth, and fluctuation and transformation [bianhua 變化] appear.[66]

The space existing between heaven and earth is the probability space. It is acted upon by humans (interpreted here as the dissipative structure with self-organization capabilities) responding to the auspicious and ominous signs and signals (emanating from heaven), and the forms and emergence arise on earth as manifestations. Dissipative structures and self-organization are concepts from nonequilibrium thermodynamics that describe systems far from thermal equilibrium and capable of self-generating patterns and structures. These concepts have been applied to Yijing to understand the complex and dynamic relationships between the different elements of the world and the patterns of change that emerge from those relationships.

[63] Prigogine (2003)
[64] G. Nicolis, 'Fluctuations around Nonequilibrium States in Open Nonlinear Systems', *Journal of Statistical Physics*, 6.2–3 (1972), 195–222 <https://doi.org/10.1007/BF01023688> (p. 195).
[65] Joseph A. Adler, *The Original Meaning of the Yijing: Commentary on the Scripture of Change (p. 43)*.
[66] Joseph A. Adler, *The Original Meaning of the Yijing: Commentary on the Scripture of Change (p. 262)*.

Thermodynamics of information and Yijing

Thermodynamics of information is a branch of physics that focuses on the relationship between information and entropy.[67] This field explores how information storage, transfer, and processing are related to the laws of thermodynamics, particularly the second law, which states that entropy in an isolated system will tend to increase over time. On the other hand, complexity science is an interdisciplinary field that explores the relationships between complex systems, such as living organisms, ecosystems, and economies. Complex systems exhibit behaviour that is difficult to predict and are often composed of many interacting parts that are difficult to understand. Probabilistic emergence is a concept central to both thermodynamics of information and complexity science. It refers to the idea that complex systems can emerge from simpler components through a process of probabilistic self-organization. This occurs when the interactions between the components lead to the formation of complex patterns and behaviours that cannot be predicted from the properties of the individual components alone.

The thermodynamics of information provides a framework for understanding the relationships between information and entropy and how this affects the behaviour of complex systems. For example, it has been shown that the storage, transfer, and processing of information in complex systems is related to the increase in entropy. This relationship is essential for understanding how complex systems can evolve and change over time and how information can shape the behaviour of these systems.

The thermodynamics of information and complexity science offer a framework for understanding the relationships between information, entropy, and complex systems. The concept of probabilistic emergence connects these two fields, allowing us to understand better how information and entropy can drive the self-organization of complex systems and shape their behaviour over time. These fields offer valuable insights into the relationships between information, entropy, and complexity, providing a foundation for understanding the behaviour of complex systems and the forces that drive their evolution.

This paper has shown that Yijing's hexagrams and change lines can be applied to complex systems, capturing the balance between stability and instability, order and disorder (Figure 5). In addition, the principles of the Yijing have been applied to fields such as thermodynamics, entropy, and information state, offering a holistic understanding of the relationships between these systems.

The interpretation of the hexagrams and change lines provides insight into the nature of the relationships between the constituent parts of complex systems and the interplay between these forces in shaping the world.

As in entropy and information theory, information has also been applied to Yijing to understand the patterns and relationships described by the hexagrams. In this view, the hexagrams can be seen as information representing the different phase transitions, states and relationships between yin and yang.

[67] Juan M. R. Parrondo, Jordan M. Horowitz, and Takahiro Sagawa, 'Thermodynamics of Information', *Nature Physics*, 11.2 (2015), 131–39 <https://doi.org/10.1038/nphys3230>.

Overall, applying these concepts to the Yijing is a way of exploring the underlying patterns and relationships described by the hexagrams in a new and different light and can provide new insights into the philosophy and practices associated with the Yijing. However, it is essential to note that these concepts are not part of the original understanding of the Yijing, and their application is a matter of interpretation and speculation. Therefore, this paper attempts to draw such linkages to show complete information embedded in the energy flux "where everything implicates everything in an order of undivided wholeness" [68]. However, no observer can access the complete information but abstract a part of it for sensemaking and operate within the bounds and limits of the incomplete information. Bohm[69] asserted that "not only is undivided wholeness implied in the content of physics (notably relativity and quantum theory) but also in the manner of working in physics" (p. 181). Analogically, complete information is carried by a continuous, unbreakable energy flux. "Quantum communication and quantum cryptography are now becoming practical and important in the secure transfer of information. The basic idea is to encode the information into quantum states of matter or radiation and transmit it over long distances as energy flux".

Information is encoded in energy flux to be deciphered by the conscious observer/'ren'. The observer has a limited information capacity and cognitive constraints.[70] Lozano-Durán and Arranz [71] discussed the problems of causality, modelling and chaotic systems formulated in information theory language where causality is quantified by the information flux (containing all the variables of interest) in the dynamical system. Whether it is information or energy, they are complete and indestructible.[72] "Physical information is indestructible".[73] "The law of energy conservation states that energy cannot be created or destroyed, only transformed from one form to another. This law is one of the most fundamental principles in physics and has far-reaching implications for various scientific disciplines,

[68] (Bohm, 2002, p. 197)
[69] Bohm (2002)
[70] Q. H. Vuong, 'Mindsponge Theory' (De Gruyter, 2023).
[71] Adrián Lozano-Durán and Gonzalo Arranz, 'Information-Theoretic Formulation of Dynamical Systems: Causality, Modeling, and Control', *Physical Review Research*, 4.2 (2022), 023195 <https://doi.org/10.1103/PhysRevResearch.4.023195>.
[72] The concept of energy and information that cannot be created or destroyed is based on the laws of thermodynamics and information theory. According to the first law of thermodynamics (also known as the law of conservation of energy), energy cannot be created or destroyed, only transformed from one form to another. This means that the total amount of energy in a system remains constant, even though it may change form or be transferred from one object to another. Similarly, according to the laws of information theory, information cannot be created or destroyed, only transferred, stored, or transformed. This means that the total amount of information in a system remains constant, even though it may change form or be processed in different ways. Together, these principles suggest that energy and information are fundamental and persistent aspects of the universe, and that their creation and destruction are not possible. This has important implications for fields such as physics, engineering, and computer science, where energy and information are critical components of systems and processes.
[73] Jan Kåhre, 'Deterministic Dynamics', in *The Mathematical Theory of Information* (Boston, MA: Springer US, 2002), pp. 326–63 <https://doi.org/10.1007/978-1-4615-0975-2_11> (p. 326).

from thermodynamics to cosmology".[74] The concept of cause and effect or karmic law[75] is based on the idea that actions have consequences and every effect has a cause. In a way, the law of energy conservation could be seen as supporting the principle of cause and effect. Just as energy cannot disappear without a trace, the consequences of our actions cannot be erased without a cause. The flow of energy or information, like the flow of events, is determined by the laws of nature and is subject to the principle of cause and effect. Thus, the law of energy conservation and the concept of cause and effect highlight the idea that underlying principles govern the natural world and that everything is connected in a web of cause-and-effect relationships and information. Information causality refers to the idea that information influences events and outcomes. In Yijing, information causality is expressed through the concept of hexagrams, which are symbolic representations of change and evolving situations. The text's interpretation of the hexagrams is based on the idea that divination can provide insights into future events and help guide decision-making by providing information about potential outcomes. Thus, information causality plays a central role (in the fluctuations) in Yijing's understanding of the universe and the relationships between individuals and their environment.

> The Yi as a book cannot be kept at a distance; as a Way it is always shifting. It fluctuates and moves without rest, revolving and flowing through the six vacancies, rising and falling with no constancy, the firm and yielding [lines] changing into each other. They cannot be considered fixed essences, as they simply change along with circumstances.
> Going and coming in turns, it causes one to understand caution within and without.[76]

The concept of causality, or the relationship between cause and effect, is central to Yijing. The hexagrams in the Yijing are used to interpret the causes and effects of events and suggest potential outcomes and actions that one can take. In this sense, the Yijing can be seen as having a strong emphasis on information causality, as it is used to understand the relationships between different aspects of the world and make decisions based on that understanding.

Mutual causality – the cause-and-effect connection

The causality described in the Yijing is based on a different philosophical and cultural tradition than the causality described by modern science. The Yijing is rooted in ancient Chinese philosophy, which

[74] (Smith, 2010, p. 56)

[75] Karmic law is a concept from Hindu, Buddhist, and Jain philosophies that states that actions have consequences, and that one's current experiences are the result of past actions. This concept can be seen as a manifestation of the law of causality, which states that events are connected by a chain of cause and effect.

[76] Joseph A. Adler, *The Original Meaning of the Yijing: Commentary on the Scripture of Change (p. 296)*.

views the world as a dynamic and interconnected system in which events are interlinked and interdependent. It emphasizes that change is a natural and constant aspect of the world and that events are not caused by a single, linear chain of cause and effect but are instead the result of complex, interrelated patterns and relationships.

In contrast, modern science operates under the assumption that causality is a linear and predictable chain of cause and effect based on the laws of nature. This approach is based on empirical observation and experimentation and seeks to understand the underlying mechanisms that govern the natural world. While Yijing and modern science have different approaches to causality, both have been influential in their respective cultural and historical contexts. The Yijing continues to be widely used and studied in Chinese culture as a tool for divination and a philosophical text that explores the nature of change and the interplay between the material and spiritual realms. In the West, the scientific method has been the basis for many technological and medical advancements of the past few centuries.

Liu[77] provided a detailed examination of the concepts of change and causality in Yijing and how they differ from Western views of causality. Liu discussed the differences between the linear concept of time in Western philosophy and the cyclical concept of time in Yijing and provided insights into how Yijing construes the relationship between time and change (cyclical) and how this differs from Western views of time and causality (linear). According to Liu, Yijing conceived time as cyclical and relational rather than linear and absolute. The text presents the idea that events in the world are interconnected and influence one another and that change is a natural and inevitable part of the universe. Liu presented "a comparative analytical study of the notions of time and change in the Yijing. It analyzes Yijing's philosophy of time as a version of the B-theory[78] of time, which regards time as having multiple timelines without any 'privileged' present. In Yijing's hexagram, events and situations are characterized by earlier than, simultaneous with, and later than relationships"[79].

The concept of time in Yijing is also linked to the idea of the Tao, or ultimate reality, which is seen as the source of all things and the underlying principle that governs the universe. This paper argued that the concept of time in Yijing is more compatible with modern physics than the linear and absolute concept of time in Western philosophy; furthermore, the holistic and relational understanding of time presented in Yijing is similar to the idea of time as a relational concept in physics, where the passage of time is dependent on the observer's perspective and subsequent action and the state of the universe. Yijing's cyclical and relational understanding of time may offer a more holistic and coherent experience

[77] J. Liu, 'The B-Theory of Time and the Notion of Change in the Yijing', *Frontiers of Philosophy in China*, 12.1 (2017), 72–89.
[78] A-theory of time refers to the unidirectional time with a one-directional arrow, progressing into a future that has yet come, thus the future time is relative to the present time (in relations to the present). B-theory of time refers to time as eternal where no moment in time is ontologically privileged; each moment is related to others within a particular timeline. Liu (2017) explained that "there is no single time flow; there may be multiple timelines that are not parallel to one another as they occupy different regions of the universe" (p. 75).
[79] Liu (2017, p.72).

than the Western linear view. Capra also provided an overview of the similarities and differences between Eastern and Western views of reality, including a discussion of the differences between the causality described in the Yijing and the causality described by modern science[80]. In Eastern mysticism and modern physics, there is a recognition of the interconnectedness of all things and the idea that underlying the apparent diversity and complexity of the world is a unifying principle or ultimate reality. In Eastern mysticism, causation is often seen as cyclic and holistic, with actions in the world being seen as interdependent and ultimately flowing from the Tao, or ultimate reality.

In contrast, in Western philosophy, causation is often viewed as linear and reductionist, with individual causes leading to individual effects. In the East, time is often seen as a cyclical and relative concept, with the cycles of birth and death, day and night, and the seasons seen as reflecting a larger cyclical pattern in the universe (multiple timelines that are not parallel where no moment in time is ontologically privileged but relationally connected to other timelines). In contrast, in the West, time is often seen as linear and absolute, with a clear distinction between past, present, and future. In "The Tao of Physics", Capra argued that modern physics supports a holistic and interconnected view of reality and that the principles of quantum physics can be seen as parallel to the concepts in Eastern mysticism. For example, the idea of non-locality in quantum physics, where particles can instantaneously affect each other regardless of the distance between them, is similar to the notion of interdependence in Eastern mysticism. Capra presented an interesting comparison between the concepts of causation and time in Eastern mysticism and Western philosophy and suggested that modern physics may support a holistic and interconnected view of reality.

The causality described in the Yijing is based on ancient Chinese philosophy and cosmology. It reflects a holistic and interconnected view of the world that is different from the mechanistic and reductionist view of causality in science.

CONCLUSION

This paper provides a compelling argument for the connections between Yijing and modern physics, including complexity science, quantum physics, thermodynamics, dissipative structures, and entropy. Yijing's approach involves understanding the underlying reality that gives rise to physical events, similar to probabilistic emergence, indeterminism, and the involvement of humanity (‘ren’) in the probability space between heaven and earth. In a way, Yijing frames an entropy/emergence system approach and provides valuable metaphors, concepts and theories that are fundamental in investigating the intractable disorderliness in the observable world. Yijing describes the series of adapting and co-evolving states (the changing hexagrams) characterized by unpredictability and co-evolution, where everything depends on implicated relations and connections. Framing in complexity science terms,

[80] Fritjof Capra, ‘The Tao of Physics: An Exploration of the Parallels between Modern Physics and Eastern Mysticism’ (Shambhala Publications, 1975).

Yijing's hexagrams and the relationships between yin and yang lines demonstrate the principles of complexity and self-organization, reflecting the complex and dynamic nature of the world and its interconnected systems. Quantum physics also parallels Yijing's understanding of the interconnectedness of all things and the probabilistic nature of reality, where the relationship between the observer and the observed influences the outcome. The dependent co-arising and emergence concepts in Yijing may have much to contribute and guide the direction of quantum and complexity science. The advent of advanced AI and computing technology hopes for a scientific analysis of the complex fine-grained interactions of co-arising factors into a coarse-grained emergence not achievable with limited human abilities. In this respect, human cognitive abilities have limitations and operate by reduction of complexity by selecting only a limited amount of information available in the environment (incomplete information) for sensemaking. Yijing is based on the idea that the world is in a state of constant change and that the hexagrams can reveal insights into a particular situation's underlying dynamics. The hexagrams are interpreted through intuitive access, meaning that the observer is encouraged to approach the text in a non-literal, symbolic and analogical way. The interpretation of the hexagrams is not based on strict definitions but rather on the associations and resonances that each hexagram evokes in the observer, thus wholly subjective.

For example, the hexagrams are often associated with various natural phenomena, such as mountains, rivers, thunder, and wind, as well as human emotions, relationships, and states of mind. By interpreting the hexagrams through these analogies and metaphors, the observer can gain a deeper understanding of the situation and insight into potential outcomes. In essence, the Yijing is a tool for self-discovery and gaining insight into the world around us. By approaching the hexagrams through intuitive access and metaphorical and analogical reference, the observers tap into their wisdom and insights and use the Yijing to gain greater understanding and clarity in their lives.

Thermodynamics, dissipative structures, and entropy, which describe the flow and transformation of energy, also connect with Yijing's understanding of change and evolution in the physical world. In the Yijing, change and evolution are described through the transformations of the hexagrams, reflecting the principle of entropy, where all systems move towards disorder and increase entropy over time.

Ultimately, this paper highlights the importance of considering ancient practices, such as divination, as a source of knowledge and understanding about the nature of reality and the universe. Furthermore, the connections drawn between the Yijing, complexity science, quantum physics, thermodynamics, dissipative structures, and entropy provide a rich and interdisciplinary perspective on the world and our place in it, emphasizing humanity's role and free will in shaping the probability space between heaven and earth.

The Yijing philosophy is based on balance and change in the universe, with everything constantly in flux. This can be seen as being related to modern concepts of information theory and the idea that information changes can influence physical changes. However, Yijing is primarily based on

philosophical and spiritual beliefs rather than scientific principles. The Yijing hexagram is often used as a tool for divination, with its 64 possible combinations providing guidance and insight into different situations. However, the interpretation of a given hexagram can change over time as new information and cultural context are considered. This reflects the dynamic and evolving nature of the Yijing philosophy and its ability to adapt to changing circumstances.

Overall, the Yijing philosophy can be seen as a fluid and flexible system, influenced by informational changes where everything is impermanent, and chaos principles apply. The environment conditions the actions of humans, and therefore the interplay of humans, heaven and earth engender possibilistic emergence. Yijing provides a guide to the trajectory of the ever-changing phenomena since everything and everyone is implicated, interconnected and interdependent (congruent with Bohm's theory where everything is implicated and connected[81]) through mutual causalities as all outcomes are conditioned by co-arising causes in the environment.

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