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Communication

Quantum theory-based physical model of the human body in TCM

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ABSTRACT

In the study, a quantum resonant cavity model based on wave-particle duality was proposed for the explanation of the dynamic processes of essence, vigor, and spirit in the human body in traditional Chinese medicine (TCM). It is assumed that there is a macro human order parameter (wave function), and its dynamics are governed by a macro potential field reflecting influences from heaven, earth, and society, and satisfy the generalized Schrodinger equation. This proposed model was applied in the study to interpret basic concepts of human body in TCM, with an aim to unfold the TCM development in the future.

1 Introduction

The human body is an open and complex system [1], which encompasses a huge amount of information ranging from physiology to psychology, and also from structure to function in biology. Because of the complexity, the governing rules of the human body are beyond the scope of contemporary scientific research, so that the existing knowledge about human body appears fragmented and unsystematic [2]. Traditional Chinese medicine (TCM) owns different philosophies and profound understandings about the nature of life, and has established a model based of Yin-Yang and five elements. The biggest difference between TCM and western medicine in terms of explaining the human body model is that the former contains far more knowledge beyond the body anatomical structures. For example, TCM uses essence (精), vigor (气), and spirit (神) to describe the health status of people, an approach that proved to be effective in history. The human body model in TCM [3] also emphasizes the unitary integrity of human life, including the unity in form and spirit, in the five internal subsystems, and the unity between man and society, man and nature. Therefore, its concept of human being goes far beyond the scope of anatomical knowledge, which needs to be explained in the modern scientific logic.

The exploration of Qi, meridians, and visceral theory in TCM has long been the focus of some scientific researchers. With the help of modern physical and chemical methods and bio-technologies, researchers hope to find evidence-based TCM materials and physiology as well as marked effects so as to scientifically interpret human body models in TCM. However, explaining TCM concepts scientifically is not something can be easily

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realized. As ZHANG Qicheng claimed [4], the scientificity or non-scientificity of TCM concepts proved by current scientific experiments with tools or proper methods based on mainstream reductionism is but another strange antinomy in TCM research.

The incomprehension of TCM philosophies might stem from limitations to epistemology and methodology in the study of complex systems of the human body. The ontology of the human body, however, provides a basic physical model for TCM study. And thanks to the advanced development of contemporary science [5, 6] in the 20th century, such as the presence of quantum physics, non-equilibrium dynamics, and complex systems, a comprehensive human model or a human complex system model (HCSM) could thus be established. In this study, how to construct such an HCSM in TCM was explored under the framework of quantum science and complex systems [7, 8]. This model, the HCSM, hopefully will provide new epistemology and methodology to interpret TCM concepts interestingly and efficiently.

2 Human system views based on quantum mechanics

2.1 QIAN Xuesen's concept of human beings and nature

In the 1980s, QIAN Xuesen claimed that in-depth study on body functions should be performed to develop human body science. He added that we should at least know how to protect the existing functions in our body first, then we can talk about stimulating potential functions in our body [9]. Moreover, QIAN Xuesen advocated that the development of human body science should be based on system science that fully recognizes the complexity of the human body and comprehensively integrates knowledge in various aspects. QIAN Xuesen believed that human body science included four levels: philosophy of human nature, basic science principle, technical science, and engineering practice. Comprehending the complexity of human beings and explaining the functions in the human body systematically are two biggest difficulties in creating human body science, which means a breakthrough in epistemology seems indispensable.

QIAN Xuesen [1] divided the philosophy of human nature into three parts: cosmology, macrocosm, and microcosm. "The first part is to investigate the relations between human beings and the universe, the second is to explore the relation between the human body and environment, and the third is to study the microscopic (quantum mechanics) basis of the human-nature relationship." The macro concept of human nature is manifested both in TCM concepts and in the knowledge with ancient origins, such as Confucianism, Buddhism, and Taoism. However, a quantum mechanics-based explanation for the relation between human beings and nature seems necessary. So, according to QIAN Xuesen's viewpoints, we explored (i) the construction of a new epistemology on a human being based on quantum mechanics, and (ii) the interpretation of the ideology of TCM.

2.2 Human life study based on quantum mechanics

In the early 20th century, the birth of quantum mechanics yielded a revolutionary insight for the micro world, especially the "wave-particle duality", which had overturned the traditional understanding of the empirical world [10]. Quantum mechanics think the microworld is both particle-like and wave-like. There are various magic quantum effects that are associated with this micro word, such as quantum entanglement and quantum uncertainty. Do these quantum effects exist in our macro world? The answer is positive. In physics, superconductivity and superfluidity are two typical macroscopic quantum phenomena that only exist under low temperatures. The low temperature could create quantum coherence, allowing highly ordered structures, such as Cooper pair to take their form and then expand to a macroscopic scale. Here, an interesting proposition is whether the high ordered structures in life system and macro-quantum coherence are homologous in nature?

A conjecture was proposed that the universe emerge fundamentally from the vacuum and presented as quantum excitations [8]. In another word, all macroscopic things are the continuation of microscopic quantum excitation, and encompass some residual quantum coherence. Thus we assumed that the highly ordered life system is a macroscopic quantum excitation with quantum coherence to a large degree, accounting for the functions observed in the life system, including cross-scale coupling from DNA molecules, cells and tissues to the whole, and for the overall organization of the life system.

In order to verify this hypothesis, a wave function, an order parameter proposed by LANDAU [11, 12], was applied in the study to describe the ordered structure in human beings. This quantum theory-based hypothesis provided additional perspectives for the study on life system. To be specific, the wave function can be determined in two parts: part one is the density amplitude, which describes the visible structures, including molecules, cells, tissues, etc. These are also subjects in contemporary science (i.e., chemistry and biology); part two is the phase, which is related to an intangible and virtual world, but the world determines all motions of visible things. In another word, there is particle-wave duality in the motions inside a macro human body system. In this paper, we started from the quantum mechanics perspective of human life, and studied various wave movements within the life system (especially the human life system) and the flows the movements produced, hoping to open a new chapter for understanding human life and TCM theories.

2.3 Epistemology and methodology under the quantum view for life system

If the life system is a macroscopic quantum system, what would be the new epistemology for the study on life system? What would be the new methodology? They are two questions of fundamental importance.

2.3.1 Epistemology for complex life system Life system is complex, for its quantum coherence covers many scales, from micro atomic and molecular scale (10^{-10} meters) to human body scale (10^{0} meters), and even greater if taking into account the order of social organizations. Therefore, a human life system contains cross-scale coupling that spans more than 10 orders of magnitude in scale, forming a great extent of complexity within itself and resulting in greatly varied functions in each individual. However, medical science shouldn't always focus on common features of human beings, but also on different attributes in each individual. At present, our scientific research primarily focuses on changes and interactions among molecules and cells, and on establishing universally applied biological principles through animal experiments. However, few fruitful results regarding the depiction of the specificity of peoples' health have been yielded from those studies. Apparently, some new perspectives are needed.

Therefore, the methodology of quantum physics should be introduced to the study on human life. But the world of quantum physics is intangible and can't be easily explored using traditional methodology of experimental physics. Such traditional methodology has been primarily applied in traditional experiments designed specifically to verify a hypothesis. To fulfill the purpose of this study, the methodology should pay attention to interference-free observation, and make predictions and verify the hypothesis based on the observations quantifying the process of life development. Under this epistemology, a normal process in the life system shouldn't be interfered with in the experiments so as to yield ideal results in the scientific research on human life.

Furthermore, the complex system should have more than one correct quantitative model (i.e., those systems having only one quantitative model would not be complex). All successful complex system models might have their "blind spot" that cannot be explained. Therefore, the counter-evidence method should not be applied. Good models could yield comprehensive predictions for realistic system behavior and stand for long-term verification.

2.3.2 Methodology of complex life system A complex life system model must survive from the test of its accuracy for comprehensive predictions in practice. The methodology of the complex life system research is summarized as follows [8].

(i) Integration of qualitative research to quantitative research with meta-synthesis. This method originates from QIAN Xuesen's idea on the essence of complex systems' motion. For starters, as human body is an extremely complex system, a group of experts who have expertise in different subjects and disciplines are relied upon to form a comprehensive, in-depth, and detailed framework of knowledge in this field, and construct prediction models that are helpful in practice guidance.

(ii) Knowledge pagoda method. This method can be summarized as multi-level expression, level-by-level quantification, multiple iterations, and gradual approximation. Human behavior needs to be described at multiple levels, and a uni-directional causality description needs to be replaced with two-way causality or even with multi-way network causality. Under the multi-layer causal network representation, the accuracy and certainty are continuously improved by constantly verifying prediction against observations at the current cognitive level. During the iteration under different space-time backgrounds, cognition and practice can be compared, paired or even developed together.

3 A physical model of the human quantum resonant cavity

3.1 Wave equation of human order parameter

Under the guidance of the above ideas, this study attempts to establish a new physical model of the human body by assuming the human body is a quantum resonant cavity, which contains quantum resonant waves with frequencies of various oscillations that promote the movement of neural currents and blood flows in the human body. Phase waves, because of their integrity, are not only the medium of communication among various parts of the life system, but also the main channel of interaction between the internal and external environment. Their movement patterns may vary in time but are always consistent with the biological evolution of the life system, and are synchronous with the evolution of biological structure. In detail, these phase waves form a multi-dimensional and multi-level composite phase field (CPF), which determines the energy distribution of, in TCM terms, the five elements and the twelve meridians in the human body.

Specifically, the mathematical description of the human quantum resonant cavity is the macro quantum wave function of human body with a potential field U reflecting relevant macroscopic coupling with the environment. The wave-function satisfies the generalized Schrodinger equation:

$$i\hbar\frac{\partial\psi}{\partial t} = H\psi = (T+U)\psi \quad (1)$$

where $T = -\frac{\hbar^2}{2m}\nabla^2$ is the kinetic energy operator. The expression of the wave function in the human body is

$$\psi = \sqrt{\rho(r,t)}e^{i\theta(r,t)} \tag{2}$$

The amplitude part $\rho(r,t)$ corresponds to the human body structure (i.e. the density field of molecules, cells, tissues, etc.), and the phase part $\theta(r,t)$ is the CPF. Both $\rho(r,t)$ and $\theta(r,t)$ represent functions of time and space. In the study, we interpreted the human body as both intangible and tangible, which is an innovative perspective. The tangible are molecules, cells, and tissues in the body and the intangible is the phase field [13]. According to the one yuan and two sides theory for the life system [7], the tangible and intangible constitute two sides (that is, Yin and Yang in TCM theory), which are complementary under the guidance of oneness (i.e. Tai Chi in Taoism Philosophy). When Yin and Yang are well balanced, suggesting a human being is in good health. Wave function is the manifestation of the oneness of the human body in mathematics, which includes the phase coherence of the whole, so as to achieve a coherent multi-scale coupling enabling a healthy body to become a self-organized whole.

To introduce the Medland transformation [14], obtaining a hydrodynamic expression of the Schrodinger equation seems necessary:

$$\frac{\partial\rho}{\partial t} = -\nabla\cdot\vec{J} \tag{3}$$

$$\frac{\partial\theta}{\partial t} = -\frac{1}{\hbar}\left(\frac{1}{2}m\left|\vec{v}\right|^2 - \frac{\hbar^2}{2m\sqrt{\rho}}\Delta\sqrt{\rho} + U\right) \tag{4}$$

where $\vec{J}$ is the phase flow proportional to phase gradient $\nabla\theta$, and a vector potential $\vec{A}$ of any electromagnetic field (which is common in a human body):

$$\vec{J} = \rho\vec{v} = \frac{\rho}{m}\left(\hbar\nabla\theta - q\vec{A}\right) \tag{5}$$

Equation (3) is the mass conservation equation of the continuous medium. A familiar expression is that the phase flow $\vec{J}$ drives the evolution of the density field. This provides an explanation for a TCM theory, Qi flows outside the pulse and blood inside the pulse, which means blood moves under the impetus of Qi, and the movement of blood is smooth while the human body is full of Qi. In our model, Qi is an intangible phase flow (virtual), and blood is a tangible density field (real). The two are coupled through Equation (3), reflecting the influences of the intangible on the tangible concerning the human body. Equation (4) is the phase evolution equation, which describes the change of CPF driven by kinetic energy and potential energy, and represents the influence of energies on phase, in which the quantum potential originates from the spatial change of amplitude, and represents the influence of the tangible on the intangible concerning the human body. Equations (3) – (5) show that the energy process is the most direct and important physical process in the operation of the human system. Equation (4) shows that the energy drives the time evolution of human body's phase potential, while Equation (5) shows that the spatial gradient of phase potential and electromagnetic vector potential form a flow, that is what we call phase flow. Equation (3) shows that the phase flow drives the motion of the solid density field. Therefore, the physical mechanism of the Qi and blood movements uses the composite phase field as intermediary, the internal and external energy potential of the human body drives the physical movement.

3.2 Interpreting TCM with quantum resonant cavity model

According to the human quantum resonant cavity model, TCM theories, including Visceral Manifestation, meridians, and Qi, can be interpreted within the framework of CPF in detailed studies (Figure 1). The external CPF includes both the Five Movements and Six Climate (the potential field of the heaven-earth system) in TCM, as well as the human consciousness field originated from

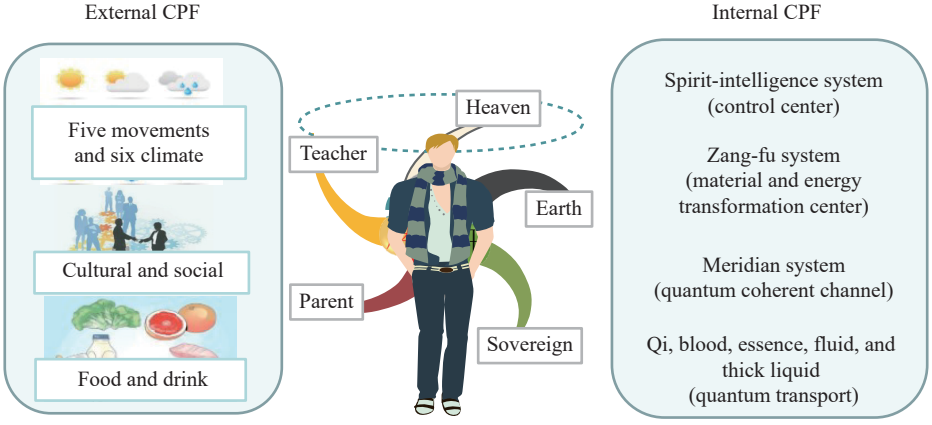

Figure 1 The sketch map of the human quantum resonant cavity model

cultural and social influences, and the food, water, and sunshine that directly impact the human body. All these factors contribute to the constitution of a multi-level environment surrounding the human body. As for the internal CPF, it can be divided into four major parts. The first part is the spirit-intelligence system, according to the five viscera hidden spirit theory (heart to hide vitality, lung to hide spirit, liver to hide soul, spleen to hide intention, and kidney to hide aspiration) in TCM, the system, connecting to the brain via nerves and to the five viscera, controls the whole human body and regulates the Qi, blood flow, and consciousness in the body. The second part is the zang-fu system which involves the internal organs located at the thorax and abdomen, delivering fresh air and food through the nose and mouth into the body. These organs are essential in transforming the material to energy in the human body. The third part is the meridian system, the quantum coherent channel connecting the orifices, limbs, and internal organs, enabling communications between the internal and external, up and down. Communications between the anatomically visible blood vessels and the intangible meridians, as well as transportation of Qi, blood, essence, fluid, and thick liquid are parts of the duty of the meridian system. A mathematical modeling of the transportation of meridians has been carried out based on fluid mechanics [15], and further verification is needed in combination with clinical data. The fourth part is the Qi, blood, essence, fluid, and thick liquid, the material and energy sources of quantum transport.

Next, we will describe the internal motion of Qi and blood, two quantum fluids. The movement of Qi corresponds to the movement of light substances, such as ions flowing in electrical activities, and the movement of blood corresponds to the movement of heavy substances, such as blood, tissue fluid, and lymph. However, both of their movements possess quantum resonant waves with various frequencies. By emphasizing the quantum waves (such as light-like waves), we can distinguish classical (mechanical) waves and describe the quantum nature of Qi as an ontological oscillation of time and space, needless of any medium, but can be transformed into one another with cross-scale correlation, thus connecting the viscera to realize various functions of human body. Quantum oscillations are constantly in harmony with the outside world. Once the harmony is damaged, people may become sick. Taking the multi-level organic ecosystem and self-regulating principles into account, we believe, is a new perspective for TCM quantitatively diagnosis.

The ideas mentioned above also provide a new perspective about the difference between human body and other lifeless objects. The biggest difference is that human beingss are living objects with conscience (intangible) and initiative behaviors (tangible). The interaction between the intangible and the tangible can be described using the coupling between the amplitude and phase of the wave function. In other words, the tangible behaviors of human beings (such as heart or pulse palpitations) can be described by appropriate multi-scale phase flow. This description can also account for another important feature of human life motion, namely, the intrinsic uncertainty within a human body being homologous to the uncertainty of quantum motion.

4 Summary

This physical model of the human body based on quantum theories is applicable to clinical research relating to “active health” awareness. From a quantum perspective, the human body (amplitude) and consciousness (phase) are mutually influential and inextricably linked. Therefore, health recovery is not simply a matter of treatment for the visible organs, but also of enhancing the orderliness of the consciousness field. In the *Plain Questions · Ancient Innocence* (*Su Wen · Shang Gu Tian Zhen Lun*, 《素问·上古天真论》) [the first chapter of the famous *Yellow Emperor’s Inner Classics* (*Huang Di Nei Jing*, 《黄帝内经》)], an ordinary man, a supreme man, and a sage are defined based on the degree of harmony they are in with nature. They have quantum resonances with extremely large spatial and temporal scales, having realized the highest degree of celestial unity. It is suggested that to achieve the optimol health status should have the consciousness field resonating in harmony with the great consciousness field of heaven-earth, and obey the laws of nature. In the end, we hope that the models and ideas proposed in this study could build a bridge in better understanding our health conditions, and create a more harmonious relation for us human beings with nature.

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Competing interests

The authors declare no conflict of interest.

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基于量子观的中医人体物理模型

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【摘要】基于量子波粒二象性,我们提出了中医人体精气神运动的量子谐振腔模型。我们假设存在宏观人体序参量(波函数),其运动由反映天地和社会影响的宏观势场推动,满足广义薛定谔方程。本文将这一人体量子模型应用于对中医人体基本概念的解读,并以此展望中医应用的未来。

【关键词】量子谐振腔;中医;人体物理模型;复杂系统;序参量