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# Interpretation of Traditional Chinese Thinking using a Systems Theory Approach: Dialectical Materialism

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**Abstract:** This study uses the formulation of systems theory to systematically interpret three ancient Chinese theories – the theory of the five elements, the theory of yin-yang, and the theory of qi. The five elements theory explains the internal structure and linkages of things; the theory of qi explains the change mechanism of materials, energy, and information both internally and externally; and the theory of yin-yang explains the conditions for the harmonious development of things and the reasons for their evolution. Together, these theories explain the laws and internal mechanisms of movement, change, and the development of things. Traditional Chinese thinking contains abundant dialectical materialism that is waiting for us to discover and apply.

*Keywords*: Philosophy of Marxism; Chinese traditional thinking; Systems theory; Dynamical system; Eigenvalue

## 1. Basic concept and principle

### 1.1 Integrity

The ancient Chinese ideologists espoused the integrity of thinking, whereby the matter to be solved is regarded as an organic integrity. Systems theory also lays emphasis on the integrity and interrelation of internal elements. In this essay, we study an object with a complex system: a nonlinear open dynamical system that features

contact with the outside world and has an internal operating mechanism. It can be written as:

$$\dot{x} = f(x) \qquad x \in \Omega \tag{1}$$

where $x \in \Omega$ is the state vector and consists of $n$ components, $x_i$, $i = 1, 2, \cdots, n$ are the state variables, $\Omega$ is an open subset of $R^n$, and $f$ is a sufficiently smooth nonlinear vector function.

## 1.2 Equilibrium state

The concept of equilibrium was introduced from Newtonian mechanics, whereby an object is at rest or in uniform linear motion when the resultant external force is zero. The state vector $x_0 \in \Omega$ is called the equilibrium point of the system if $f(x_0) = 0$.

Engels pointed out in *Dialectics of Nature* that "equilibrium is inseparable from motion"[1] and "the possibility of bodies being at relative rest, the possibility of temporary states of equilibrium, is the essential condition for the differentiation of matter and hence for life." [2] Engels also noted in *Anti-Duhring* that "there is no such thing as absolute rest, unconditional equilibrium." [3]

At the equilibrium point $x_0$, we have

$$\frac{dx}{dt} = 0.$$

The state variable no longer changes over time. The linearized system can thus be written as

$$\frac{dx}{dt} = Ax$$

where $A$ is the Jacobian matrix evaluated at $x_0$, $A = Df(x_0)$.

## 1.3 Structure

A complex system is composed of several subsystems with specific functions that are interrelated and form a well-ordered system structure. The functions and attributes depend on the system's structure. Each functional subsystem also features an internal structure and mechanism and runs in a certain mode that forms its structure.

Each functional subsystem must have certain material bases, and has an organic integrity through the exchange of substances, energy, and information. When a functional subsystem changes, other functional subsystems are bound to change,

which eventually has an effect on the original functional subsystem, forming a causal loop.

Inter-promotion and inter-restraint constitute a kind of causal relation, where the existence of an element brings about the growth of another element. For example, the growth rate of element *B* is subject to that of element *A*, as element *A* powers the sustainable development of element *B*.

Let us examine a simple case. When the element scale is indicated with only one scalar and the growth rate of element *B* is only subject to that of element *A*, it can be formulated by the differential equation:

$$\frac{dx_B}{dt} = \alpha x_A$$

where $x_A$ and $x_B$ are the variables for elements *A* and *B*, and $\alpha$ refers to the growth rate of element *A* relative to element *B*. When $\alpha > 0$, element *A* generates element *B*; when $\alpha < 0$, element *A* restricts the growth of element *B*.

Given *n* elements, $x_1, x_2, \cdots, x_n$. $x_1$ generates $x_2$, ..., $x_{n-1}$ generates $x_n$, $x_n$ generates $x_1$, thus forming a circular causal chain. The linearized dynamical system of (1) has the following structure.

$$\frac{d}{dt}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{pmatrix} = \begin{pmatrix} 0 & 0 & \cdots & 0 & \alpha_1 \\ \alpha_2 & 0 & \cdots & 0 & 0 \\ 0 & \alpha_3 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & & \vdots \\ 0 & 0 & \cdots & \alpha_n & 0 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{pmatrix}$$

where $\alpha_1, \alpha_2, \cdots, \alpha_n$ are positive constants. Let $\alpha = (\alpha_1 \alpha_2 \cdots \alpha_n)^{1/n}$ or $\alpha^n = \alpha_1 \alpha_2 \cdots \alpha_n$. The system that we study is a multi-loop circulatory system.

## 1.4　Yin and yang property of the system

Yin and yang is a fundamental philosophy of ancient China that can be used to explain the movement and development of any object in the world. Yin and yang refer to the properties of an object, the connotation of which was derived from obverse and reverse sunshine and then extended to heaven and earth, the sun and the moon, man and woman, day and night, cold and hot, light and dark, action and rest, and so on. Yin and yang can also be used to describe the law of movement.

Let

$$A = \begin{pmatrix} 0 & 0 & \cdots & 0 & \alpha_1 \\ \alpha_2 & 0 & \cdots & 0 & 0 \\ 0 & \alpha_3 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & & \vdots \\ 0 & 0 & \cdots & \alpha_n & 0 \end{pmatrix}$$

The characteristic equation of $A$ is

$$\lambda^n - \alpha^n = 0$$

Thus, the eigenvalues of $A$ are $\lambda_k = \alpha e^{2k\pi i/n} = \alpha\left(\cos\left(\dfrac{2k\pi}{n}\right) + i\sin\left(\dfrac{2k\pi}{n}\right)\right)$,

$k = 0, \cdots, n-1$.

Each eigenvalue of the system has its corresponding eigenspace. The stable eigenspace $E^s$ is the space spanned by the eigenvectors, the corresponding eigenvalues of which have negative real parts, and the unstable eigenspace $E^u$ is the space spanned by the eigenvectors, the corresponding eigenvalues of which have positive real parts. When the state variables belong to the stable eigenspace, they flow forward in time to the equilibrium point; whereas when the state variables belong to the unstable eigenspace, they flow backward in time to the equilibrium point.

An equilibrium point $x_0$ is said to be hyperbolic if the Jacobian matrix $A = Df(x_0)$ has no eigenvalues with zero real parts. At a hyperbolic equilibrium point, the stable and unstable manifolds can be defined as:

$$W^s(x_0) = \left\{ x \in \Omega \mid \lim_{t \to \infty} \varphi_t(x) = x_0 \right\}$$

$$W^u(x_0) = \left\{ x \in \Omega \mid \lim_{t \to -\infty} \varphi_t(x) = x_0 \right\}$$

where $\varphi_t(x)$ is the flow of the nonlinear system of (1). The stable manifold $W^s(x_0)$ represents the set of points that flow forward in time to the equilibrium point, and the unstable manifold $W^u(x_0)$ represents the set of points that flow backward in time to the equilibrium point.

As Engels pointed out in *Dialectics of Nature*, "the basic form of all motion is

approximation and separation, contraction and expansion – in short, the old polar opposites of attraction and repulsion." [4]

According to *Zhuangzi · Zeyang*, "Yin and yang are the strongest vital energies." [5] In *Zhuangzi · Natural Laws*, a thing "Shares the virtue of yin when he is still and shares the movement with yang when he is active." [6]  In terms of the properties of yin and yang, a stable manifold pertains to yin, which means that the kinetic energy lessens toward rest with time and finally reaches the equilibrium state, and an unstable manifold pertains to yang, which means that the kinetic energy increases toward movement with time and finally evolves away from the equilibrium state.

Yin-yang theory focuses on the opposition, interdependence, waxing-waning, and mutual transformation of yin and yang. The object that we study is an organic integrity. In ancient China, yin and yang are used to describe the changes and the laws of movement, and "the philosophy of yin and yang makes up the Tao." The waxing and waning of yin and yang are indispensable, and constitute the law of an object's development. A chain reaction may occur when an object goes wrong, which may be irreversible. The mutual transformation between yin and yang can be used to explain the evolutionary process of movement in abnormal situations.

## 2.  Law of development

### 2.1  Operation and evolution

Different objects are mixed to form a new object that features some of the properties and functions of the original object. Objects with different characteristics can make a new object with new properties and functions. Shibo of the West Zhou Dynasty said, "Harmony is necessary for the creation of everything. An identical thing is unable to exist for ever. So we shall mix different things together to reach a balance. This is called harmony. Thus, all things on earth can flourish. Here, the same things will be abandoned if they are piled up. Therefore, the emperors in the past created everything with the combination of earth, gold, wood, water, and fire" (Guoyu · Zhengyu).

An object, as an open system, must exchange with its external environment to metabolize various forms of substances, energy, and information. The necessary material bases and a special structure are essential to generate the required functions. Similarly, the subsystem of each function must exchange substances, energy, and information with other subsystems to play its role in the main system. Again, a

functional subsystem requires the material bases and special structure to generate its functions.

Everything in the world exists in unceasing motion due to changes in energy and physical form. Function is displayed through the exchange of substances, energy, and information within a system, among subsystems, and with the external environment.

When an object is in motion, energy plays the driving role and the object's substance is the carrier of that energy. In other words, the object cannot move without the transformation of energy. Substances with different amounts of energy collide and generate energy conversion. Substances in a state of relative rest gain kinetic energy to keep moving, whereas those in a state of relative motion use up some energy to control that motion. An object's movement is referred to as its qi activity, which keeps the object running well. An object's movement due to changes in energy and physical form is called qi transformation. The fixation, storage, transfer, and release of energy cannot be achieved without the synthesis and decomposition of substances, and the synthesis and decomposition of substances are coupled with the storage and release of energy. Only when new substances come into being and existing substances are replaced does metabolism occur and the physical form and vitality of an object can be attained.

Yin and yang are properties of movement. Increasing kinetic energy over time pertains to yang, whereas decreasing kinetic energy over time pertains to yin. Yin and yang are interdependent. As long as yin and yang remain balanced, an object can develop healthily.

An object, as an open system, exchanges with the external environment various forms of substances, energy, and information. The object possesses special functions and a structure, and the internal reciprocal transformation of kinetic energy and substances follows the intrinsic law of movement. At the same time, the internal kinetic energy and the physical form are kept in a state of dynamic equilibrium, which is the so-called "balance between yin and yang," during which stage an object develops smoothly and healthily.

In the state of "balance between yin and yang," the system cannot move too close to the equilibrium state, as it may lose power. Similarly, the system cannot move too far from the equilibrium state, as the movement may not be controlled. The object's attraction and repulsion and stability and instability cannot go beyond the defined scope, as the system may go wrong. Yin and yang are properties of movement, so an

"excess" or "deficiency" may result in problems. Only when yin and yang reach a relative balance in the course of waxing and waning can an object could maintain a state of movement.

When an object is in a state of balanced yin and yang for some time, it may evolve toward a completely different mode that moves away from the existing equilibrium state if the external environment changes irregularly or the object's structure is no longer conducive to its development.

Laozi pointed out in the Tao Te Ching that "All things connote the yin and yang," [7] which means that the movement of everything has two states: relative rest and conspicuous change. When an object is in a state of relative rest, the change is continuously weakened or even removed in a negative feedback mechanism, so the system remains stable and the object moves close to the equilibrium state. Similarly, when an object is in a state of conspicuous change, the change continuously increases in a positive feedback mechanism, and so the system cannot remain stable and the object is far from the existing equilibrium state. In other words, the object evolves from one state to another.

In the evolutionary process, nonlinear factors play a vital role. The changes in an object are characterized by path dependence and irreversibility. When the system moves beyond the existing equilibrium state, the original structure cannot run effectively, but instead becomes unstable and disordered. The system may oscillate dramatically, exceed the critical condition, and finally break down. Subject to various nonlinear factors and external forces, the system is continuously evolving to reach a new equilibrium state. Around a new equilibrium state, the object's negative feedback mechanism may again play a decisive role, so that the system can promptly contract and move closer to the new equilibrium state while a new structure and functions are being set up. The transition from one equilibrium state to another can be compared to the evolution from an out-of-date system structure to an up-to-date structure that is more suitable to the object's development and can better adapt to the new environment. In short, an object changes from relative rest to conspicuous change when the equilibrium state is broken. When an object reaches a new equilibrium state, it changes from conspicuous change to relative rest. This is also called a mutual transformation between yin and yang.

## 2.2 Law of mutual change of quality and quantity

Measure refers to a range of quantity within which an object keeps its own properties.

Around the equilibrium state, the object is developing smoothly and orderly, and there is a balance between yin and yang. The object retains its functions and structure if changes are within a certain range. Only the quantity and degree are changed.

When yin and yang are imbalanced, especially when yin cannot restrain yang, then the object becomes out of control. When the change exceeds the object's range, the nature and structure may be radically changed and the object may move beyond the current equilibrium state. If the structure of the object is not completely changed, then the internal difference and conflicts may further expand until the internal relation falls apart and the object as a whole collapses. Only when the nature and structure are changed completely will the object find a new equilibrium point. Around a new equilibrium state, the object's internal conflicts will be resolved and a new qualitative change will come into being. In short, the object repeatedly progresses from quantitative to qualitative change. As pointed out by Mao Zedong in *On Contradiction*, "There are two states of motion in all things, that of relative rest and that of conspicuous change. Both are caused by the struggle between the two contradictory elements contained in a thing. When the thing is in the first state of motion, it is undergoing only quantitative and not qualitative change and consequently presents the outward appearance of being at rest. When the thing is in the second state of motion, the quantitative change of the first state has already reached a culminating point and gives rise to the dissolution of the thing as an entity and thereupon a qualitative change ensues, hence the appearance of a conspicuous change. "[8]

## 2.3 Law of the negation of the negation

The development of an object involves unceasing self-development and self-improvement, which may pause, become rigid in structure, and finally head toward death. The extinction of an old object is always accompanied by the birth of a new object. The law of the negation of the negation reveals this spiral or wave-like development process.

An object optimizes its structure in the waxing and waning of yin and yang and reaches harmony with the environment through the unceasing exchange of substances and energy in a balance between yin and yang. This is the positive process by which an object maintains its existence.

If the object, as a system, cannot adapt itself to environmental change due to its rigid structure, then an imbalance of yin and yang may occur. When the internal contradictions are so fierce that the object cannot tolerate them, then its structure will

not be able to adapt to the development and the system will move beyond the equilibrium state, its nature may change, and the object may die. This is the negative process of the object.

These fluctuating processes are also the processes that the object seeks to achieve a new equilibrium state. Only when the equilibrium state that accords with the development is found is the object tested in the new environment around the new equilibrium state. The structure must meet its internal demands and adapt to the new environment, so that it can reach a new stable and harmonious state. This proves that the object is invincible. Outdated and negative parts are abandoned for new forms and content, allowing the object to evolve from a low to a high level.

## 2.4 Law of the unity of opposites

Contradiction refers to the contradictory but unified relations within the object, which are universal and arise from differences in the process of development.

### 2.4.1 Identity and struggle of contradiction

An object must possess its own internal structure and functions to form a system. The elements of an object are interrelated, such that movement is not limited to a certain element only. Local fluctuations may result in further fluctuations and chain-reactions in the overall system, and thus each element may change more or less successively. The object is unceasingly moving to maintain its vitality.

The movement of an object is limited within a certain range, otherwise the structure or nature will change. The object may fail when it grows beyond a certain point, that is to say, "as soon as a thing reaches its extremity, it reverses its course." Such fluctuation is essential to maintain relative stability and vitality. The contradictory elements are interdependent and mutually cooperative, which is the identity of contradiction.

Nothing in the world can keep its nature and physical form forever. When pathological changes occur in the internal mechanism, the movement of an object may become out of control and be influenced by changes in the external environment. If the movement goes beyond the tolerable scope, then the structure may be destroyed. Relieving the contradiction is one of two methods of maintaining an existing system structure, and is parallel to the "Keeping Quiet" advocated by Laozi. The other is to comply with the object development, that is, to alter the existing system structure. If a system structure that fits the system operation and the current environmental changes can be found, then the object will maintain its vitality. However, an object with a rigid

structure is very subject to external effects, and a tiny disturbance may result in the collapse of the system structure. "The supple and weak overcomes the rigid and strong" as Laozi puts it, emphasizing that the system structure should have variability and plasticity. It is a tough decision as to whether to maintain the original structure or to change the system structure in line with its environment; to emphasize stability or to go with the tide of development. The contradictory elements have different values. If they achieve a compromise, then the object may find a new equilibrium point and keep going under the conditions agreed by both sides; if the conflict becomes acute and cannot be mediated, then the struggle may be extremely fierce. The elements deny, restrict, and repulse each other to cancel out the conflict, which is the struggle of contradiction.

When internal differences and contradiction are further extended, conflict is inevitable, because functionally there is a positive feedback mechanism inside the system. This mechanism is the driving force of development, and can impel the decomposition of the system structure and a change in equilibrium state. If the internal structure becomes rigid and the object cannot adapt itself to the development, then the driving force of development destroys the original system structure and triggers the establishment of a new system structure, or a new equilibrium state that is more suitable to the development. The object's nature is radically changed, and the old object is replaced and metabolism maintained.

**2.4.2 Internal causes are the basis of change and external causes are the condition of change**

An object exchanges substances, energy, and information with an external environment that constantly varies. The object adjusts its system structure to adapt itself to the changes in external environment.

When the external environment changes abnormally, a vigorous object can make adjustments to maintain its dynamic equilibrium and protect its basic structure. However, if the changes in the external environment go beyond the tolerable range, then the object's dynamic equilibrium will be affected and the basic structure may be destroyed.

External causes are the prerequisite for the existence and development of an object. Changes in the external environment may result in abnormal variation due to changes in the running state. However, the object's internal mechanism can make adjustments within its limits to cancel out the effects of the outside world. In other words, the

object must alter its internal structure and running state to create a mechanism that is a good fit for the environment to gain more vitality by making the most of environmental changes. As pointed out by Mao Zedong in On Contradiction, "external causes are the condition of change and internal causes are the basis of change, and that external causes become operative through internal causes".[9]    "The fundamental cause of the development of a thing is not external but internal; it lies in the contradictoriness within the thing. There is internal contradiction in every single thing, hence its motion and development. Contradictoriness within a thing is the fundamental cause of its development, while its interrelations and interactions with other things are secondary causes." [10]

## 3.    Conclusion

Traditional Chinese thinking and materialistic dialectics express the mechanism of movement and the process of object development in different languages. The former is a new and effective tool to enrich and develop the latter.

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