

**Title: Epistemology based on Quantum Theory**

**- General principles of Cognition from the perspective of quantum theory**

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## **Abstract**

Modern quantum theory sees the essence of existence as energy. Energy uses quantized waves as its essential mechanism. Life and humans perceive this as particles for the efficiency of perception. It is not that matter itself has the duality of waves and particles, but that our perception is dually structured for the efficiency of perception.

The ‘wave-particle duality’ and ‘observer effect’ seen in the double slit experiment may be such simple contents. This is not that energy itself is dual, but that human perception has developed into a dual structure of essence and phenomenon. We aim to clarify this based on quantum theory.

## **Title: Quantum-based epistemology**

### **- General principles of cognition from the perspective of quantum theory**

#### **1. Quantum-based ontology**

The basis of existence is energy, and the essence of energy is the wave mechanism. We perceive this as a particle for the efficiency of cognition.

1. It is not that matter itself has the duality of waves and particles, but that our cognition is dually structured for the efficiency of cognition. Wave cognition is not easy to perceive, so it is inefficient. However, if we fix it as a phenomenal particle and perceive it, the efficiency of cognition increases. We can see that life and humans have evolved in this way for survival.

2. We conceptually understood this cognition structure that we have as the concepts of subjectivity and objectivity, emotion and reason. This is the basic paradigm of existing philosophical epistemology. However, based on quantum theory, we believe that there is a reason to distinguish between essence and phenomenon.

The world is made of energy, and the essential mechanism of energy is a simple and efficient structure, wave. Waves have a structure that is faithful to the law of conservation of energy, and are very efficient in storing, transmitting, and converting energy. In general space, it is completely efficient.

3. What is discovered here is insight into our dualistic cognitive structure and scientific systematization of existing epistemology. The origin of the existing cognitive paradigm of ideal and reality, idea and phenomenon, theory and reality, inner and outer, and even consciousness and unconsciousness was a multidimensional effort to view the reality of the world in a balanced way.

I believe that this can be theorized as a dualistic structure of 'phenomena and essence' according to quantum theory. We have understood the dichotomous perception or various views as differences in perspectives or values, but we have not found a way to clearly resolve this. We need to understand that this problem originates from our dualistic cognitive structure of viewing essence and phenomenon, and we should find a scientific solution in this natural principle paradigm.

4. The new scientific perception that understands existence by dividing it into essence and phenomenon presents us with a rational and flexible paradigm. This can help us understand the reality of our long-standing dualistic cognitive structure and overcome the resulting errors and conflicts.

#### **2. The essence and phenomenon of existence shown by the double-slit experiment**

The 'observer effect' of the double-slit experiment may be simple. It shows that humans perceive the wave, which is the essence of energy, as a phenomenal particle for the efficiency of perception.

This does not mean that energy itself is dualistic, but that human perception has developed into a dual structure of essence and phenomenon. This means that the existing macroscopic theory of classical mechanics centered on phenomenal particles (mass) can be reinterpreted as a quantum field theory centered on the essence, wave (energy density).

This is a very challenging task now, but it can become a new goal of physics that needs to be newly pioneered through the development of quantum theory.

## I. Particle-like behavior

Existence can be expressed as a state in which a particle has a high probability of being at a specific location.

$$P(\vec{r}) = |\psi(\vec{r})|^2$$

This equation shows the probability that existence is found at a specific location with a high probability in quantum theory.

·  $|\psi(\vec{r})|^2$ : Position probability density of the factor

· Since  $\psi(\vec{r})$  does not change with time in a time-independent state, it can be defined as follows.

$\psi(\vec{r}) = A e^{i\phi(\vec{r})}$ ,  $i = \sqrt{-1}$  The imaginary unit  $i$  plays a key role in the complex number representation, and the complex number is expressed in the form of .

·  $A$  is the amplitude of the wave, and  $\phi$  is the phase according to the location.

·  $e^{i\phi(\vec{r})}$  is expressed in the complex number form in the Euler formula. It is  $e^{i\phi} = \cos(\phi) + i\sin(\phi)$ . This complex number representation is essential for the interference, phase change, and probability density calculation of the wave function in quantum mechanics. However, the value that can actually be measured is the square of the absolute value of the complex number, i.e.,  $|\psi(\vec{r})|^2 = A^2$ , which is a real value.

## 2. Wave-like behavior

The wave-like nature of a particle appears as interference and diffraction patterns in space. The wave is spread out in space and is expressed by the wave equation. In the time-independent case, it can be expressed using the eigenstate solution of the Schrödinger equation.

$$\psi(\vec{r}) = \sum_n c_n \phi_n(\vec{r})$$

·  $\phi_n(\vec{r})$  is the wave function of the eigenstate (energy level) in space.

·  $c_n$  is the coefficient for each eigenstate.

It can be seen that the wave-functional vibration structure of the quantum is a very efficient form for energy conservation and transfer, exchange, and conversion.

## Dual structure of Cognition

It is known that the quantum, which is energy, has particle-wave duality, but it can be seen that it is the structure of the wave equation, which is a single essence, as in the formula. However, our perception fixes the wave as a phenomenal particle for efficiency. However, it is believed that we deeply sense the omitted wave behind the perception. This appears in the universal emotion and artistic sensibility of humans.

Quantum theory combines the appearances of particles and waves and expresses them as a wave function that includes both the particle probability distribution, which is a phenomenon, and the interference pattern of the wave, which is an essence. The total probability density of the wave function can be expressed as follows.

$$|\psi(\vec{r})|^2 = \left| \sum_n c_n \phi_n(\vec{r}) \right|^2$$

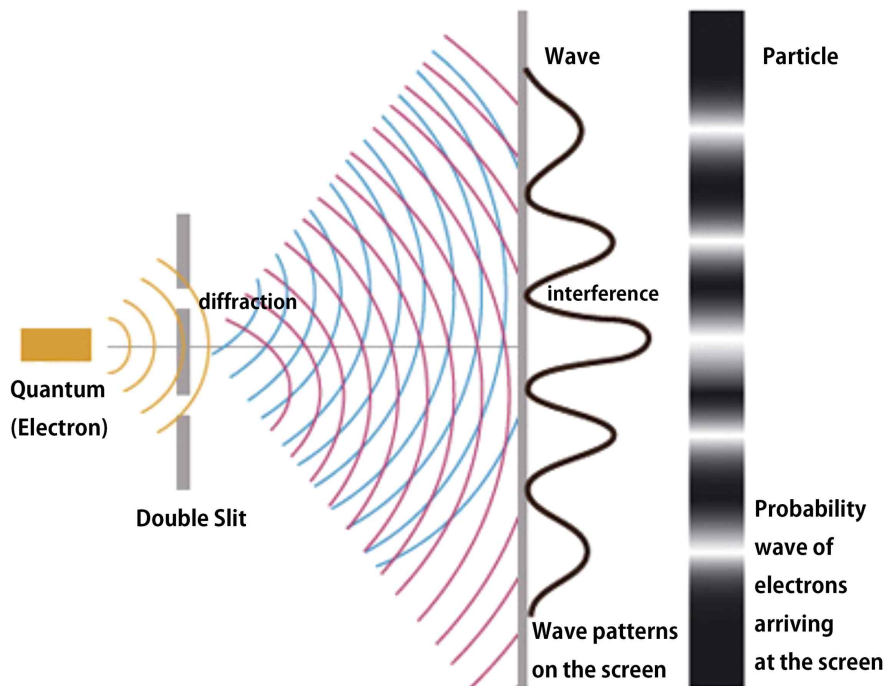
·The appearance of the particle  $|\psi(\vec{r})|^2$  is expressed as the maximum value at a specific location of

· It is the phenomenal appearance of matter. ·The wave form appears as an interference effect of  $\phi_n(\vec{r})$ . It is the essential form of matter.

The left side is the phenomenal form of matter, and the right side is the essential form of matter. We need a sense and perception of the essential structure behind the phenomenon.

In quantum theory, which explains matter, waves are a basic concept that expresses the behavior of particles and show various forms and functions. Wave functions, superposition, interference, tunneling, quantum entanglement, quantum fields, etc. create the unique behavioral characteristics of quantum. Understanding the wave equation of quantum theory is essential to understanding the relationship between the wave energy, which is the essence, and the particle (matter), which is the phenomenon.

Figure 1



### The process of perceiving wave energy

Humans are also material beings made of wave energy. It can be seen that the five senses and inertial senses of humans have evolved into a system that essentially feels and perceives energy and the essential waves of the world. In other words, they have developed into a sensory system that communicates with the wave energy of an object.

In particular, the senses of sight, hearing, and touch directly feel and interpret the wave energy of an object. The senses of smell and taste are also functions that feel and interpret the chemical energy density and composition of an object.

We sympathize with the beautiful scenery of nature and the spectrum of lines and colors in various paintings. We are moved by the delicate melody and creative rhythm of music. We thrill together to the energy emitted by the essence of life through dynamic sports movements that create the creative movement of the 'ball'. In addition, our bodies directly sense the composition of the density of sophisticated energy sensed by the scent of flowers and the flavor of coffee.

The essence of all these senses and energies is waves. We resonate with the rhythm created by the nature of the universe and are also wave functions as energy that creates nature of the universe. Therefore, we are both individuals and whole, and both whole and individual. The a priori intuitive world of life and humans is more fundamentally in harmony with natural principles than any big data created by science. In addition, reason, the natural principle reasoning system that interprets intuitive data, has a richness and sophistication that no artificial intelligence can match. The natural principle system of a priori emotions and reason that humans possess cannot be easily imitated by anything artificial. We need to realize that our a priori cognitive system is an essential attribute of the universal principle.

### **3. Integration of Phenomenon and Essence Recognition Needed**

The way humans perceive waves as matter is a result of the needs necessary for survival and evolution. In other words, they selectively perceive only the wave frequencies corresponding to the necessary matter. It is a structure that selectively perceives visible light excluding ultraviolet and infrared rays among light, and selectively perceives only the audible wave frequency band excluding ultrasonic waves and low frequencies among sound. This fact can be the basis of the principle that our perception perceives high-density organic waves as matter.

1. In this way, the selected material waves become phenomenal sensory data and form primary perception. However, this does not reflect the reality of oneself and nature. (A priori emotional function)

2. Here, a comprehensive understanding that includes the wave function omitted in primary perception through three-dimensional inference is necessary. This is a secondary perception process that understands the essence. (A priori rational function)

3. We have focused on primary phenomenon recognition so far, and accordingly, science can be said to have focused on systematic interpretation of phenomena. Therefore, the cognitive paradigm of 'simultaneous recognition of phenomenon and essence' needs to be generalized and made common sense.

### **4. Conclusion**

The particle-wave theory of quantum theory is a useful case for understanding the dualistic relationship between essence and phenomenon in our perception, and can be presented as a universal principle of perception.

It is not that matter itself has the duality of waves and particles, but that our perception is composed of the dualistic principle of phenomenon and essence for cognitive efficiency. We can see that we need to have personal cognitive habits, social practices, and institutions that understand the structure of the phenomenal appearance and essential principle of an object in the process of cognition.