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Photon Is the Ultimate Elementary Particle of Matter

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Abstract: According to the entropy increases principle, I make a deduction that photon is ultimate elementary particle of matter and further more, it shows photon's physical characteristic and physical constants affect the physical law and physical constants of the whole universe. In this essay, I try to take a lead for the study of elementary particles and the grand unified physics.

Key words: photon, elementary particle, information, entropy, rest mass, grand unification.

1. Preface

Physicists have been searched for elementary particle of matter. But what is elementary? People find it hard to answer this question. From china ancient books--*The Book of Changes*, we know that *Taiji* produces *two Yi*. *Two Yi* produce four quadrant, four quadrant produce eight diagrams. Eight diagrams produce all the things in the universe. Grand means endless. But *the taiji* is the great void, isn't it that ZERO matter? We know that photon's rest mass is zero. If the ZERO matter is photon, isn't it that photon is "the ultimate elementary particle of matter"? We know that infinitesimal limit is zero. If so, isn't it that ultimate elementary particle of matter is photon?

Meanwhile, nowadays physicists are trying hard to search for the physics law, the physical constants and the theory of grand unification. If we have defined what the ultimate elementary particle is, we're then sure that the physics law and the physical constants of the ultimate elementary particle have certain relation with the physics law and the physical constants in the universe.

The modern superstring theory is considered as grand unification by some people, a theory which includes everything and describes every natural power under the mathematical framework. In the view of superstring theory, string is the most basic unit and all the elemental particle which formed the universe, for example, electron, photon, quark and neutrino are its specific states. Up till now, the string theory is only a scientific hypothesis. The human being haven't observed the basic string, yet. The superstring theory is very hard to be proved through experiment, since the extra dimension space is curled so limited, people have to build a particle accelerator as enormously as the galaxy to do the experiment.

According to Kurt Friedrich Gödel's un-completeness theorem on math field, in any self-evident axiom form system, there always exists a problem which could not be proved right or wrong of its definition. That's to say any theory has some unsolved problems. Therefore, the grand unification doesn't include all the branch physics theories, while it becomes a common and basic part of all the branch physics. So it must be the most simple and elegant one.

I try to take a lead for the study of elementary particle and the grand unification. This essay is based on the existing theories (e.g. theory of relativity, thermodynamics law) and then it forms a new theory. After all, it isn't built on a new hypothesis.

2. Quantization of information

Claude E. Shannon pointed out information is a kind of characteristic which describes the statistics of a system, is also a basic attribute of the system that they're the organized measurement. Shannon's basic theorem show that a system's containing information equals to the fewest digits of binary system in which we code the perfect describing statistics. The information of a system reflects its possible existing state magnitude. The unit of information measurement is bit. A bit of information is two equal possibilities but chosen one amount of information. For example, one certain system has 2^r possible states. Then its amount of information is r bits.

To observe the possible states is restricted by the Heisenberg uncertainty principle and people's measuring level. Different measuring levels lead to different records of information. In a complete sealed system, we can describe lots of states precisely. We often call them micro states. In the field of quantum mechanics, we consider them as the possible system quantum states. These micro states gather together on different kinds due to different sorts of coarse granulating (which could be called macro states). In a defined macro state, micro states could be considered as equivalence, so we often care the numbers of micro states.

At the same time, if we don't know the final components of a matter or the deepest layer of structure, we could not count the amount of the information and could not calculate their Shannon entropy of the structure. But we can find deeper layer structure in which we could calculate the information amounts. By the development of micromotion technique, we can imagine that in the future quarks could be used to store information. May be a quark could store a bit of information.

3. Shannon entropy

Shannon entropy reflects an uncertainty of a random experiment (or random variable). A random experiment can be expressed as:

$$X = \begin{pmatrix} 1 & 2 & \dots & n \\ p_1 & p_2 & \dots & p_n \end{pmatrix}$$

In the formula, $1, 2, \dots, n$ express the possible result, while p_n shows i 's probability. X 's uncertain value is decided by n 's value and p_n 's distributing even rate. The uncertainty is a function of (p_1, p_2, \dots, p_n) and is marked as H . it has the next qualities:

- (1) Symmetric continuity. Viz. $H(p_1, p_2, \dots, p_n)$ is the symmetrical continuous function of (p_1, p_2, \dots, p_n) ;
- (2) $H(0, 1) = 0$;
- (3) If $q = q_n + q_{n+1}$, then $H(p_1, p_2, \dots, p_n, p_{n+1}) = H(p_1, p_2, \dots, p_n, q) + qH(p_n/q, p_{n+1}/q)$.

Through the math deduction, we get the Shannon entropy:

$$H(X) = H(p_1, p_2, \dots, p_n) = - \sum_{i=1}^n p_i \log_2 p_i$$

\log 's base is 2, and the unit of $H(X)$ is bit.

If (X, Y) are the duality random variables, valued as (x, y) , $x = 1, 2, \dots, m$, $y = 1, 2, \dots, n$. The united probability distribution is p_{ij} , then their united entropies are:

$$H(X, Y) = - \sum_{i=1}^m \sum_{j=1}^n p_{ij} \log_2 p_{ij}$$

We call $H(Y|X) = H(X, Y) - H(X)$ as Y for X's conditional entropy. It shows the conditional uncertainty. When Y doesn't depend on X, viz. X and Y are separately independent, $H(Y|X) = H(Y)$. we get:

$$H(X, Y) = H(X) + H(Y)$$

As is known from the concept, thermodynamics entropy has the same equipollence with the Shannon entropy. When Shannon tries to quantify the information from a information, he naturally gets a same formula as Boltzmann's. Boltzmann entropy which represents different forming numbers reflects the amount of Shannon information which is ready for meeting a certain compound mode.

4. A conservation law for entropy and information

Entropy and information have a conservation law that in a information and entropy keep conservative, and equal to the biggest information or the biggest entropy. Viz.:

$$H + I = H_{max} = I_{max} = const$$

H and I refer to the values of entropy and information. H_{max} and I_{max} refer to the most possible values of entropy and information.

The entropy increase principle can be described as the information decrease principle. Namely the information in a sole system can get to its smallest information.

Entropy is an uncertainty measurement. When information is obtained and recorded, energy was used up. In this circumstance the uncertainty decreases. At the same time the recorded information increases. When the record is cleaned, the recorded information decreases. But the uncertainties in the whole closed system increase by the same amounts.

At the same time, entropy has some relation with coarse granulating, viz. it has something to do with the extent of the described system. Surely, if all the details of a system are considered, we think that their entropy won't increase in the view of math again. So the entropy keeps constant. But in fact, if a system has many parts, we only use some variables to describe it. These smaller variables will add up to other variables due to their orderliness with the running of time. And then the former ones no longer become orderly. This is the concept of the second law for thermodynamics.

Not only the record of information but also the record of entropy, its result has something to do with people's measuring level and people's considering variables. When we measuring more accurately and consider more variables, we will find out more micro information.

5. The transfer from macro information into micro information

Whether the probability scatters evenly or not shows that a system has distinguished information. We divide the space into 2^r "macro phases". We look on the macro phase information as the needed informations by a group of probabilities which are corresponding with these phases. The probabilities which are distributed in the macro phases can be defined as micro information.

In fact, we divide each “macro phase” into 2^l “micro phase”. We look on the micro information as a group of corresponding messages needed by the probabilities. Meanwhile, we look on the macro information as the knowledge by which we understand the quality of the whole system. Then we look on the micro information as the knowledge by which we concretely understand every micro particle. In other words, micro information shows that we understand every particle’s related speed.

Let’s imagine an experiment that in a corner of a close space we place a sealed bottle of perfume in it. The bottle of the perfume was then placed onto a “macro phase” of a certain space. And its cube is $1/2^r$ of which the macro information is r with the running of time, we couldn’t see the changes of macro information, because it is under a restricted condition (e.g. the bottle is sealed.). If we take off the lid, with the time gone, the molecules of the perfume will escape from the bottle. And we know that the macro information is decreasing till all the macro information change into micro information. But the total amounts of information haven’t changed at all. We still can go on dividing the micro phases. With the time gone, we may use more accurate measuring method, and we may consider more variables. At last we can find that micro information will change into even more micro information.

If we define the length of even more micro information as Plank length, according to the uncertainty principle, we know that these will become the most micro information. By now if we go on dividing the even more micro information, the information will disappear in the quantum fluctuation, because we couldn’t go on doing the measuring any more. In other words, according to the information decreasing principle, when the most micro information goes on decreasing, all the information will disappear in the quantum fluctuation. At the same time, a nominal sole system and the rest parts of the world will interact and they come to action by the way of random disturbances. These perturbations will damage the relationship among the particles. Further more, they will consume the micro information.

Macro information can change into micro information and vice versa. Information comes from quantum fluctuation and produces elementary particles with information. By the interaction and relation of these elementary particles, they will produce more information, and then produce macro information. But in this process, energy will be consumed.

6. Photon is the ultimate elementary particle of matter

As we know an electron has 2^2 possible existing states (it has two electric charges and two spinning states, which is measured by people now). If you want to specify what electron it is, you need 2 digits of binary. So a sole electric, information is 2 bits. As for the photon’s spinning, it has two ways of motion which parallels the matter’s moving direction or opposite of it. Its least possible existing states are 2^1 . So a sole photon, information is 1 bit which is measured by people now. For a sole system which is formed by lots of photons, their left and right spins are equal and scattering evenly. The whole system information is 0 bit.

The least capacity of the information in an elementary particle is 1 bit. Under the uncertainty law, among the elementary particles isn’t the least information particle photon?

We know that energy and mass are the same things. If Q for heat quantity, E for energy, T for Kelvin scale, m for mass, S for thermodynamics entropy, we consider a system which has no power with the outer world, according to the first law of thermodynamics, we then get:

$$dQ = dE = dm$$

$$dS = \frac{dE}{T}$$

Obeys the principles of energy's equipartition, we get:

$$\frac{E}{T} = \text{const}$$

$$\frac{dE}{E} = d(\ln E)$$

If $dS \geq 0$, then:

$$dm \geq 0$$

Suppose a in-equilibrium sole system, it can be divided into limitless approximate equilibrium small systems. Due to the fact that entropy and mass can be summarized, we absolutely believe there is such a system, the above formulas are acceptable. Further more, in a sole in-reversible system, if given enough time, the entropy must get to its maximum value and the information must get to its minimum value. Under the restriction of uncertainty law, we can find deeper layer structure in which we could calculate the information amounts. In the deepest layer of structure, when the system information gets to zero, the micro system's single particle must have the fewest information particles among the elementary particles.

Form the theory of relativity, we get:

$$dv \geq 0$$

v stands for the speed of elementary particles in the in-reversible sole system.

It shows that the direction of entropy adding up is to make the particle's ultimate elementary particles come to the speed of light. The particle at last will break up into the ultimate elementary particle whose rest mass is zero. That's to say in a completely sole and no restriction physics system, entropy increase principle makes the system's total rest mass zero. Form the theory of relativity, a rest mass which is not a zero matter couldn't be accelerated to light speed. But we think it can be broken up into light speed photon. So photon's rest mass is zero and its information is 1 bit particle. It is the ultimate elementary particle of matter. Namely the fastest speed is photon which is also the fewest information particle. Photon is the limit while dividing the elementary.

On the other hand, we can use photon to form a coordinate in order to survey a sole physics system. Based on theory of relativity, we will find those which form the physics system are all light speed particles, viz. photon. Generally speaking, people won't build a photon coordinate to survey a sole physics system, because it is the extreme condition. But if a common physics law could not apply to an extreme condition, what is the common?

Either using information decrease principle, or entropy increase principle or photon coordinate principle to survey matter, we can draw a conclusion that photon is ultimate elementary particle of matter.

7. Information and rest mass

Suppose there are two photons A, B. They are moving in light speed. Their moving mass (total kinetic energy) are m_A , m_B . Since A, B are owning moving mass, they also have some magnetic characteristic. A and B combine into an elementary particle ----- a particle which has “strong character”, when photons interact with each other, and produce position energy.

Now, we suppose the position energy of A, B are V_A^* , V_B^* . The total moving energies are m_A^* , m_B^* . Then the total energy of A and B is:

$$V_A^* + m_A^*, V_B^* + m_B^*$$

Considering A, B as a general M, then M's total rest mass m is:

$$M = V_A^* + m_A^* + V_B^* + m_B^*$$

The rest mass (Viz. proper mass) which consists of the ultimate elementary particles is the total value of position energy produced in the circumstance that the matter's inner particles interact with each other and total moving energy produced in the circumstance that matter's inner particle are moving towards each other.

In a completely sole and no restriction physics system, following the information decrease principle, with the time going, its ultimate information is 0 bit. We can say that it has no information. At that time, the total rest mass in the whole physics system is also zero. When a physics system owns rest mass, it proves that the inner interaction between photons and particles. So it produces information and vice versa. If the physics system exists information (>1 bit), it shows that it owns rest mass. The matter's information and rest mass are produced by the interactions between photons and particles. If an electron owns information (2 bit), it also owns mass. But by now, we couldn't come to a conclusion that how much information there is decide how much rest mass there is. What we need is a further study.

Photon form matter by a certain way. By the interaction between the photons (or by the effect of power) or by transformation it will form a rest mass particle. At the same time, it will produce position energy and then produce new information and the next produce rest mass. Perhaps we can no longer survey a certain photon of the matter inner. Electron and anti electron can die into a pair of photon. Similarly, several photons could change into an electron.

8. The micro information in the whole universe

Firstly, let's consider the universe as an endless “straight line” model. In order to stress the uncertainty principle, we must divide the one dimension line into line segments. Each length of the line segments stands for the position of the particle and its possible accuracy. If we can confirm the numbers of the particles in each segment, then, about the “straight line” universe, we can use limitless sequence of the particles to express the universe which is formed by “occupation numbers” and open at both ends. The micro information is defined as: it helps us to distinguish two same statistics (macro) character occupation number sequences. Now we try to prove the two sequences are same. We will chose a subsidiary sequence from a occupation number sequence. In a limitless sequence, any length-limited subsidiary sequence will repeat to appear endless times.

According the large numbers law after finite times of attempt, we could find out some possessing same characteristic occupation subsidiary sequence. Moreover, despite the length of the chosen subsidiary, so long as the length is finite, we can find that kind of sequences.

We extend the above proof to the three-dimension endless universe. So long as it meets the condition that the strong universe principle and the part universe structure are limit, the whole universe character is all statistics (macro) and its micro information does not exist at all.

9. The physics character and physics constant of photon affect the universe's physics law and physics constant

Photon has the character of quantization. Its energy is:

$$m = \frac{h\nu}{c^2}$$

h is the Plank constant, ν is frequency.

Due to the quantization of photon, we think photon can be compounded and broken down. Nevertheless, if its rest mass is zero, it is a photon. For separate particles, they all have the same physics characteristic. Only in different fields, they show different physics characteristics.

Photon owns the characteristics of quanta and electromagnetic. Light speed is its physics constant. The universe consists of photons. So the photon's physics characteristic and constant affect the universe's physics law and constant. If the whole universe consists of many small universes, the photon's physics characteristic and constant in each small universe affect the physics law and constant of this small universe. No matter what circumstance it is, anything happening in the universe seems that its evolution is based on the science laws. All these are affected by photon's physics characteristic and constant. It is the direction for people of modern physics to study photon's physics characteristic and constant.

I believe that in the future people will know more about photon's nature and will know more about the matter's structure.

(Note: This essay is adapted from a part on "energy-momentum theory" which was written by me in 1992. it is only a chapter of my book, "The proof that photon is the ultimate elementary particle of matter". At first I named the particle whose value of rest mass is zero as zero-particle. But later I think using the word of "photon" is better.)

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Written in 1992