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# PERTAINING TO THE DISCUSSION ON THE NEW VIEW OF BASIC PARTICLES

[Following is a translation of an article by Sakada Shoichi in the Chinese-language periodical, Hung-ch'i (Red Flag), Peiping, No 6, 1 June 1965, pages 19-39. This completes the translation of all of the articles in this issue of Hung-ch'i.]

Editor's Note: The world is unlimited and full of contradictions. All things are the unity of opposites. There is not a thing that possesses no contradictions, and there is nothing that cannot be separated. One divides into two. This is a common phenomenon. This is dialectics. Nature is like this and so is society. Human knowledge is also like this. If this is denied, then it becomes metaphisics.

The development of natural sciences continuously bears witness to the truth of this Marx-Leninist view of the universe and its theory of knowledge.

Speaking in a large way of the universe, there are thousands and thousands of suns beyond the solar system. There are thousands and thousands of milky ways beyond the Milky Way. It is boundless. Speaking of the universe in a small way, it is also boundless. Whithin the atom there is the nucleus and electrons. They are the unity of opposites. The nucleus can be divided into protons and neutrons. They are also the unity of opposites. Protons unite with anti-protons and neutrons. They are also the unity of opposites. Protons and anti-protons, neutrons and anti-neutrons, etc. are basic particles which can be further sub-divided. Matter can be divided infinitely.

Man's knowledge must be continuously developed and be creative in social practices. In the process of the search for the true structure of matter, in every step taken, there are people who stop and maintain that they have found the "origin of matter." They maintain that this origin cannot be further divided and that it contains no more contradictions. They expect to draw final conclusions. The history of natural sciences has mercilessly laughed at these metaphisicists. It has more and more clearly disclosed the dialectics of the natural world.

In this issue of this publication, we publish the article "Pertaining to the Discussion on the New View of Basic Particles" by the renowned Japanese physicist Sakad Shoichi. This paper following the viewpoint of Engels in noting that elements and atoms are only "joints" in the unlimited division of matter, and Lenin's view that electrons are unlimited, based on new facts in the realm of basic particles, is full of ideas which have persuasively proved the infinitely divisible nature of matter and have shown that natural scientific theories can be infinitely developed. The essay also sharply criticizes the metaphysical and idealistic views on this problem. There are not many natural scientists who can consciously use the dialectic of materialism to guide their own research.

Comrade Mao Tse-tung always tells us to use materialistic dialectics in all our work in opposition to idealism and metaphysics. Our natural science workers after reading this essay, will be beneficially inspired in using materialistic dialectics against metaphysics in their research. Reading this essay will also do good to comrades in other fields who want to learn the dialectics of materialism.

Because this essay covers many fields of special knowledge, this publication issues at the same time a page of notes for use as reference by readers.

We should not act as the people of the past who have reduced the universe to within the confines of understanding; we should rather extend and expand knowledge, so as to obtain an image of the universe which is in accord with its original appearance.

-- Francis Bacon

# I. Basic Particles Are Definitely Not the Origin of Matter

## I. Introduction

A: After the war, many new basic particles (note seven*) were discovered one after the other. Knowledge about these particles increased rapidly. Now we believe that, taking this knowledge as a foundation, there is the possibility of obtaining a further understanding of the nature of basic particles. Today I would like to discuss my recent ideas on this matter.

B: Before you start, would you please tell me when this term "basic particle" came into being and what its meaning is?

A: Neutrons were discovered in 1932, and it became clear that the nucleus of the atom was composed of protons and neutrons. The term basic particle appeared at this time. After the appearance of the three elements of the atom -- the electron, the proton, and the neutron -- this term appeared as the general designation for them.

B: This term, basic particles, was applied to the level of the origin of matter?

A: That's right. However, since photons were at the beginning included in the basic particles, this term with regard to matter had to be understood in a slightly broaded sense.

B: Is it still correct to hold the viewpoint that basic particles constitute the original source of matter?

A: In my opinion, this viewpoint was incorrect from the very first. Actually, in 1932 people were already considering basic particles to be the most basic elements in the structure of matter, and still today they are not able to split these basic particles into even more fundamental things. But it is wrong to claim that basic particles are the original source of matter simply on the basis of this. The uncritical solidification of a viewpoint which is allowable only at a certain stage in the development of experimental technique is the arbitrary method of metaphysics, and this is incompatible with science.

* (Note one), (note two), etc. in this text correspond with sections (One) (two), etc. in the "Explanation of the 'Dialogue on the New Basic Particle Viewpoint'". For example, (note seven) refers to section seven.

B: Thus, this term, basic particles, is inappropriately used.

A: There is also the opinion which holds that terms are nothing more than designations, and that they may be used as desired. But names are for the purpose of expressing the actual, and if an inappropriate term is used, frequently even the basic nature is gradually distorted. In actuality, the viewpoint that basic particles constitute the original source of matter has already unconsciously penetrated the minds of physicists, and this would seem to be blocking the advance of science.

B: Has there been the same sort of experience with atoms?

A: This concept of "atom" which the philosophers of ancient Greece evolved contains the idea of the limitation on the divisibility of matter. The atoms which were discovered by modern science were in the beginning in accordance with the term. But by the end of the 19th century, this had already lost the original essence which had made it an "atom". At that time, the majority of physicists were worrying themselves to death over the contradiction between their hypotheses on the atom and the new empirical facts which appeared with that great revolutionary -- radium (note nine). Thus there was brought about the crisis in physics which P'eng-chia-lo spoke about in his work The Value of Science.

## 2. Electrons Are Also Inexhaustible

B: How would one go about accurately formulating the concepts of atom and basic particle?

A: With regard to this question, there is nothing more appropriate than that which Engels said in his work The Natural Dialectic. One passage states: "The difference between the new atomic theory and the previous atomic theories lies in (and we won't discuss the discarding of foolishness here) the critical point that it does not advocate that matter is simply discontinuous; it rather advocates that the various discontinuous parts (great atoms, chemical atoms, physical bodies, astronomical bodies), which belong to different stages, determine the various essentially different forms of existence of general matter." (1) /See Note./

/Note/: Engels: The Natural Dialedtic, People's Publishing House, 1960, page 248. The translation was made from the German -- translator.

If we survey the rapid development of atomic physics since the start of this century, we can clearly see that atoms are not the ultimate limit of the divisibility of matter. The atom is one of the infinite layers, differing in essence, which make up nature. I think that although basic particles now appear to be the original source of matter, it is more correct to view them as making up layers of matter.

B: Was this work by Engels, The Natural Dialectic, written before the theory of the indivisibility of the atom was overthrown by experiments?

A: As early as 1867, Engels had written in a letter to Marx: Although the atom was previously explained as being the ultimate limit of divisibility, it now only refers to a link which produces an essential difference when being split up. (2) /See Note/ It was only long after this that electrons and radioactive elements were discovered, and the natural scientists of the day knew nothing of Engels' viewpoint on the atom. They deeply believed that atoms were in name and deed the ultimate limit of the divisibility of matter. Consequently, when the new facts were uncovered, they were thrown into a state of confusion. They put aside the question of the obsolescence of their atomic views and began to suspect the existence of atoms; they fell into the positivism of not believing anything outside of empirical facts. But later atomic physicists could not but pass over the conservative viewpoint which held that the atom is the ultimate limit of the divisibility of matter and the positivism which suspected the actual existence of the atom; they consistently developed in the direction of revealing the internal structure of the deep parts of the atom.

(2) /Note 7/: Cf. Selected Correspondence of Marx and Engels, People's Publishing House, 1962, pages 199-200.

B: Do you mean to say that no one at that time adopted the atomic viewpoint of dialectical materialism to look towards the future?

A: This was regretably the case among physicists. What is noteworthy is that Lenin had already deeply analyzed the crisis in physics in his work Materialism and Empirical Criticism. He used the phrase that "electrons are also inexhaustible."

3. Basic Particles Are Not Points

A: Another reason why many physicists today hold that basic particles are almost the original source of matter is that, in order to explain such phenomena as the production, destruction, scattering, and decay (note eight) of basic particles, they utilize the quantum field theory (note four) which has the point model (note five) as its foundation. Originally it was only when the objects of research were rather large parts of time, space, or territory, which involved the neglecting of the internal structure of basic particles, that basic particles could be viewed as mathematical points (note five). But as soon as the theory which had the point model as its foundation was able to develop and achieve certain results by using strict mathematical forms, the approximate meaning which had been adopted at first was frequently forgotten and concealed by error; it came to seem that the object of research itself was a mathematical point. When this happened, since what was viewed was a mathematical point, the object of research became an original element with no internal structure. Thereupon this could not help but bring about the viewpoint that all basic particles belonged to the same layer and were the original source of matter.

B: As far as we laymen are concerned, it is very difficult to believe that basic particles are mathematical points.

A: The children who yell "the emperor isn't wearing any clothes" are right. The persons who are known as the orthodoxy (note 5) of the field theory have to a greater or lesser degree fallen into the mathematical mysticism of the Pi-ta-go-la-ssu School. Because they are confined by the illusion of the omnipotence of mathematical formulas, they do not feel that it is unnatural to view basic particles as points and to use the corresponding localized field (note 5) to describe them. The fact that the emperor can walk along the street without any clothes on, and that the people do not find this strange, is due to the fact that the mist of Copenhagen[1] (note 3) is too thick.

B: This is to say that the explanation (note 3) by the quantum theory (note 2) Copenhagen School results in our knowledge of the theory of matter being too shallow.

A: When the classical model (note 1) was discarded on the basis on complimentarity (note 3), the baby was thrown out with the bath water. The results were that this sort of atmosphere was created: It was almost a crime to believe that basic particles had an internal structure.

B: But did not the point model become suspect long ago due to its being connected with the difficulty of divergence (note 6)?

A: It was indeed suspected. But it was suspected from the mathematical viewpoint or we may say the logical viewpoint; it definitely was not suspected from the physical aspect, that is from the aspect of the object. For example, there are persons like Heisenberg who posit that if we could accurately consider the minimal unit of length, that is the existence of the universal measure (note 6), the quantum field theory could become the ultimate form without divergence; but there still were no persons who suspected that basic particles were not the origin of matter.

4. The Field Theory is not the Ultimate Theory

B: Is it right that the persons who consider basic particles to be the basic stuff of matter also consider the field theory to be the ultimate theory?

A: That's right. They posit this new mechanistic view of nature: They hold that the natural world in the final analysis is composed of basic particles, that all movement in the natural world ultimately takes the field theory, which governs the movement of basic particles, as its basis. The orthodox group holds this sort of common concept: Of course, the field theory at present has not reached a perfect state, and consequently we cannot say that it is the ultimate theory; but if in the not-too-distant future the divergence difficulty is overcome, the field theory can become the ultimate theory.

B: Hasn't the divergence difficulty already been resolved by using the correction method (Chung-cheng-hua -- 6850 2973 0553) (note 6)?

A: No, this has not been resolved. It is only in such fields as quantum electrodynamics (note 2)that a clever way was accidentally found to avoid the divergence difficulty.

B: Did not the outstanding success of the correction method in quantum electrodynamics strengthen even more the belief that the field theory, which takes the point model as its foundation, is the ultimate theory?

A: This might be so. But if we think a little more deeply, we will immediately understand that this cannot be so. If we are to use the correction method successfully, first of all we must, as prerequisites, postulate that the divergence difficulty has already been solved by using some form, and the measure of correction must be limited. Secondly, it will be essential to restrict the form of mutual interaction, by using some sort of reason, to within the special type of the so-called first mutual interaction (note 6). It can well be imagined that the field theory will not be able to satisfy these requirements.

Recently, some physicists in Japan who are doing work on nuclear energy (note 8) have advocated that if we can determine that there exists within meson theory a mutual interaction which cannot be corrected, then the field theory will all the sooner reveal its bankruptcy. In this way it could no longer be said to be the ultimate theory.

B: There have already been various sorts of opinions regarding the scope of application of the field theory.

A: The most well-known is Heisenberg's opinion on universal measure which was just mentioned. However, I think that an even more important idea was Bohr's explanation, which was published in 1930. At that time neutrons had not been discovered and it was only known that electrons and protons were elements in the structure of matter. The quantum field theory at this time was only quantum electrodynamics which undertook research on these particles and the mutual interaction of electromagnetic fields. At a Faraday commemoration address Bohr on the one hand praised the success of the quantum theory and on the other hand pointed out its shortcomings and limitations. Questions which he raised that could not be resolved with the theory of that time were those concerning two non-dimensional quantities, that is, the comparison $M/m$ of the proton mass and the electron mass and the value of the fine structure constant, $E^2/\hbar c$ (note 8). Using the language of present day science, these are the questions of how to arrive at a table of masses for basic particles, and the structure of mutual interaction. In present day field theory these two factors are brought in completely accidentally. To get at principles of these relationships, it is absolutely necessary to go outside of the scope of the field theory. This point is of extremely great significance. It shows that even if the field theory already has a perfected form, it definitely cannot be said to be the ultimate theory.

B: If it is held that basic particles constitute a layer of matter, then we should say that there is no so-called ultimate theory.

A: That is completely correct. Generally speaking, accidental factors must be included in any theory. If we want to elevate the accidental to the level of necessity, we must do research on a level which is even deeper than the layer in which the object of research is found. And if we consider that there are essential distinctions in the laws governing the various layers, then we should admit that there can be no so-called ultimate theory. If we insist upon considering a certain theory as the ultimate theory, then all the accidental factors in this might as well be considered to be accounted for by the will of God. The results are that we might just as well discard scientific research.

5. Heisenberg's Basic Particle Point

B: I recall an event which I think was the year before last (1959). There was an item in the newspaper which stated that Heisenberg had said: "After my theory is completed, physics will no longer develop in the direction of depth, but will only develop in the direction of breadth." Did he believe that he could establish the ultimate theory?

A: There is a slight difference between Heisenberg's viewpoint and the orthodox viewpoint which holds that basic particles are the basic stuff of matter. He views all basic particles as being different forms of the same original matter. The original matter which he discusses can be expressed by using the spinor field (note 7); and he postulates that it satisfies a nonlinear equation which is termed the universe equation. He holds that the universe equation can provide principles for the formation of basic particles out of original matter. Consequently solving the universe equation will account for the existence and essence of the various basic particles, which is to say that an ultimate theory could be set up which would describe the basic particles in a basic way. If the table of masses and structure of mutual interaction of basic particles could be arrived at by this theory, this would be an advance over the general field theory. He believes that an even deeper layer exists beyond basic particles, and in this point he is very similar to our theory, which we will discuss in the next section. But he believes that there is a basic stuff to matter, and that an ultimate theory can be established. In this he is fundamentally at odds with our viewpoint. His viewpoint is quite similar to the thinking of the Pi-da-go-la-ssu School and Ya-li-ssu-to-te. He holds that, due to the appearance of the universe equation, he can seek the ultimate cause of forms for all things. In sum, with regard to Heisenberg, physics reaches its conclusion with the sentence "In the beginning was the universe equation"; here he gives way to theology.

II. The New Basic Particle View

1. Introduction

B: Please discuss your new basic particle viewpoint.

A: From the preceeding discussion it can be known that my viewpoint on basic particles is that basic particles constitute one of the infinite layers differing in mass which make up the natural world. This is also to say that I am starting out from dialectical materialism. If this viewpoint is adopted, the first question is whether the thirty-odd particles, which are termed basic particles, all belong to the same layer.

B: Generally the basic particles are divided into the four classes of deuterons (p, n, $\Lambda$, $\Sigma$, $\Xi$), mesons ($\pi$, K), leptons (v, e, $\mu$), and photons ($\gamma$).

A: The mutual interaction of basic particles includes (1) strong mutual interaction, (2) weak mutual interaction, (3) electromagnetic mutual interaction (note 8). The basic particle classes which you just mentioned are differentiated on the basis of these different forms of mutual interaction. The particles which belong to the deuteron and meson classes have both strong and weak interactions; the characteristic of the lepton class is that it does not have strong mutual interaction; and photons are the intermediary of the electromagnetic mutual interaction between charged particles, and they have no other mutual interaction at all. The distinction between the deuteron and meson classes lies in the fact that the former are fermions, while the latter are bosons (note 7). But because they both possess strong mutual interaction, they are at times labeled the deuteron-meson class.

B: With regard to strong mutual interaction, I have heard that the famous Chung-ye (0022 6851) -- Hsi-tao (6007 1497) -- Gell-Mann Law has been discovered.

A: This law reflects the most characteristic basic nature of the deuteron-meson class.

## 2. The Compound Model of the Deuteron-meson Class

B: Is your compound model (note 15) of the deuteron-meson class for the purpose of explaining the Chung-yo -- Hsi-tao -- Gell-Mann Law?

A: That's right. If we adopt the orthodox viewpoint that all basic particles are the basic stuff of matter, then we can only explain this law as the will of God. But if we adopt the layer viewpoint which holds that a certain particle is a compound system of other particles, then we can reasonably explain this law. The Chung-ye -- Hsi-tao -- Gell-Mann Law determines the form of strong mutual interaction, and we can say that it is the logic of form. My undertaking is to deepen the logic of form into the logic of matter.

B: In your compound model[2)] you hold that the deuteron-meson class is made up of the basic particles of p, n, $\Lambda$, and their antiparticles. (See chart 1.)

Chart 1 The Compound Model of the Deuteron-meson Class

| Particles | Symbol | Compound State (Those with "$-$" are Anti-particles) |
|---|---|---|
| Proton | p | basic particle |
| Neutron | n | " " |
| $\Lambda$ Particle | $\Lambda$ | " " |
| $\Sigma$ Particle | $\Sigma$ | $(p\bar{n}\Lambda)$, $(n\bar{n}\Lambda)$, $(n\bar{p}\Lambda)$. |
| $\Xi$ Particle | $\Xi$ | $(\bar{p}\Lambda\Lambda)$, $(\bar{n}\Lambda\Lambda)$. |
| $\pi$ Meson | $\pi$ | $(p\bar{n})$, $(n\bar{n})$, $(n\bar{p})$. |
| K Meson | K | $(p\bar{\Lambda})$, $(n\bar{\Lambda})$. |

A: That's right. Consequently, for example, simply with regard to the $\pi$ Meson my model is completely the same as the model put forward previously by Fei-mi and Yang Chen-ning (2799 2182 1337) (note 15). But the motive power of the two sides is essentially different. The attempt by Fei-mi and Yang Chen-ning is simply for the purpose of reducing the number of basic particles; we may say that this is "thought economy". My model is put forward on the basis of the Chung-ye -- Hsi-tao -- Gell-Mann Law, that is using empirical facts as a basis; it has a lucid methodology, that is, the guiding principle in it is to develop the logic of form into the logic of matter.

B: I'd like to take this opportunity to ask you to discuss your compound model in a little more detail.

A: When the Chung-ye -- Hsi-tao -- Gell-Mann Law was discovered I felt that the circumstances of the deuteron-meson class theory were very similar to the atomic nucleus theory of 1930. In 1930, in doing research on the atomic nucleus theory, people discovered a very simple law: that is, when the mass number (note 9) is an even number, the spin of the atomic nucleus is a whole number, and when the mass number is an odd number the spin is a half whole number. They could not explain at all the significance of this law. But when neutrons were discovered in 1932, I-fan-ning-k'o and Heisenberg proposed that the atomic nucleus was a compound system made up of protons and neutrons. After this model was put forward, the law of even and odd of atomic nuclei (note 9) and other essences which were difficult to understand became the logic of simple matter. Thinking of this bit of history, I arrived at my compound model viewpoint by making an analogy with the atomic nucleus theory. I was thinking along this line: Let the historical role played by the neutron in the atomic nucleus theory be assumed by the alpha particle. When I adopted the compound model viewpoint the mystical logic of form immediately turned into the lucid logic of matter; my heart was filled with boundless joy. The replacement of the strange concept of the "singular point" (note 14) with the simple concept of the number of $\Lambda$ particles is probably a most outstanding example.

B: This is indeed the case.

A: According to my model, the compound particles $\pi$, K, $\Sigma$, and $\Xi$ belong to the same layer as the atomic nucleus. The following diagram show this:

$$\text{Molecule -- atom --}\left\{\begin{array}{l}\text{atomic nucleus}\\ \text{super pieces (note 9)}\\ \text{compound particles}\end{array}\right\}\text{-- basic particles}$$

Consequently, after our compound model theory we will still use the atomic nucleus theory as a model, and develop along the even path which it follows.

First of all, the Wei-cha-k'o mass formula (note 9) with regard to the atomic nucleus had a counterpart in the Matumoto mass formula[5] which was put forward. Although this formula was in the form of a simple yet bold hypothesis, it was not only able to calculate well the numerical value of the mass of compound particles already known, but it also had the capacity to predict unknown particles.

Secondly, we may also bring up the theory of Maki[4]. He takes the standpoint of the field theory and considers its scope of application. He has done research on the question of the $\pi$ meson corresponding to the deuterium nucleus theory (note 9). Making a comparison with the atomic nucleus theory is at times effective, but serves no function at all at other times.

A: It is just as you say. With regard to the atomic nucleus, the standard laws of quantum dynamics (note 2) may truly be applied to the movement of protons and neutrons in the nucleus. But with regard to compound particles, not only is there no guarantee at all that the field theory is applicable to their internal regions, but it is very possible that a whole different set of laws exists. I think that on the one hand we should make the situation very clear, and on the other hand perhaps we should make a bold try for a corresponding theory; this is all very significant.

B: At the present stage in which the internal laws have not been discovered, would it not be very useful to undertake investigations by using the group theory method adopted at the time of doing research on the atomic nucleus?

A: Yes. With regard to the compound model, after Ogawa[5] and Klein[6] introduced the concept of complete symmetry (note 15), the investigation of group theory also developed.

## 3. Complete Symmetry

B: What is complete symmetry?

A: If we overlook the mass differences (Chih-liang Ch'a -- 6347 6852 1567) and electrical charges of the basic particles p, n, and $\Lambda$ which make up the compound particles, they are then completely the same. This is complete symmetry. As you know, with regard to the p and n systems the independence (note 12) of charge is established. The so-called complete symmetry is a broadening of this concept so that even $\Lambda$ is included in it. This is to say that apart from the independence of charge there is also this sort of demand: With regard to the substitution of p and $\Lambda$ and the substitution of n and $\Lambda$, no change in the content of the theory is brought about.

B: Is this a new hypothesis?

A: Yes. As to whether it is correct, this can only be judged on the results. No matter what, to posit complete symmetry means that we can engage in group theory investigation as regards compound particles and consequently there will be a new development in the theory of the compound model.

B: Which group is it that corresponds to complete symmetry?

A: It is the San-wei-ma-cheng (0005 4850 7803 2973) group (note 13). Ikeda, Ohnuki, and Ogawa[7] have already made a careful investigation of the structure of this group.

B: What were the primary results of this?

A: Sawada and Yonezawa combined the investigations of the Matumoto mass formula with the group theory, seeking to obtain the position of the resonance energy level which appears in the scattering phenomenon, and they discovered that their results were surprisingly similar to the experimental results in the scattering of $\pi$ or K by the nucleus. I felt that there might be problems in the method of causing a correspondence between the value of the calculation and the experimental facts. But they were the same as the experiments within a broad scope. This point is truly noteworthy.

B: So they were surprisingly the same!

A: Apart from the resonance energy level, this also predicted the existed of a few new particles. For example, it would seem that neutral $\pi$ mesons $\pi^{0\prime}$ with an isotopic spin of zero do exist, as well as the $\Sigma$* particle which is similar to the $\Sigma$ particle, etc. The idea on the possible existence of $\pi^{0\prime}$ was put forward previously with regard to explaining the necessity of the energy distribution of positrons which are produced at the time of the $K_{e3}$ decay. With regard to the existence of $\Sigma^*$, I have heard that proof has recently been found which almost proves its existence.

B: That's a terrific result!

4. Weak Mutual Interaction and the Compound Model

B: With the standpoint of the compound model, what new approaches are brought in concerning weak mutual interaction?

A: Several new viewpoints have appeared. The first which may be mentioned is that the change in the particle itself is the characteristic of weak mutual interaction; this viewpoint is strikingly expressed. This is because, looking at things from the compound model viewpoint, basic particles cannot change due to strong mutual interaction.

B: With regard to the characteristic of weak mutual interaction, we often hear that yu-ch'eng (1342 4468) is not conserved (note 10). Can you clarify this by linking this fact with the fact that particles themselves must change, which you just mentioned?

A: I would like to do so, but up to now I still don't understand the relationship between them.

B: Even more positive results have not appeared as regards weak mutual interaction?

A: I will now discuss this question. Feynman and Gell-Mann analyzed weak mutual interaction, and revealed its essence rather clearly. According to their opinion, weak mutual interaction is brought about by charge exchange flow $J_\mu$ (we call it the Feynman-Gell-Mann Flow) (note 11) composed of deuterons and by deuterons, or by leptons and the charge exchange flow composed of leptons. It may be posited that the mutual interaction energy has the form $J_\mu^+ \cdot J_\mu$. If we adopt the compound model viewpoint, due to the fact that the basic particles of the deuteron class include only the three types p, n, and $\Lambda$, the Feynman-Gell-Mann flow only includes the two types, the flow composed of p and n and the flow composed of p and $\Lambda$. Thereupon we get this sort of law: The change of the figure (and thus the singular point) of the $\Lambda$ particle in weak mutual interaction cannot at most exceed one (that is, $\Delta S=0, \pm 1$). In experiments no facts were discovered to disrupt this law. Recently another extremely important fact was discovered, that is, the scalar product of the mass difference of $K_1^0$ and $K_2^0$ is only $10^{-5}$ electron volts.

If we satisfy the weak mutual interaction existence of $\Delta S = \pm 2$, then the above mass difference should be 10 electron volts approximately. Thus we can say that this fact vigorously supports the above law.

B: There are probably many more things worth talking about with regard to the weak mutual interaction of the compound model.

A: Apart from the above law, there is also this law which was derived from the compound model: There does not exist a flow which satisfies the relationship $(\Delta S/\Delta Q) = -1$ ($\Delta Q$ expresses the charge change). This law was also given experimental support, which is that in experiments we have not observed the phenomenon $\Sigma^+ \rightarrow n + e^+ + \nu$.

B: It is really the case.

A: There is also an important result which must be mentioned, and that is the conservation of the vector flow which was automatically brought out. The Feynman-Gell-Mann flow is composed of a vector part and an axial vector part. And the strength of the vector flow in the Beta-decay of the nucleus of the atom is almost exactly the same as the strength of the vector flow in $\mu$-decay. In order to explain this noteworthy fact, Feynman and Gell-Mann [9] introduced the hypothesis of the conservation of vector flow. However, if the standpoint of the compound model is adopted, this hypothesis becomes an implicit thing.

B: That's very interesting!

A: Moreover, with regard to axial vector flow, recently Ogawa arrived at an extremely noteworthy result. In order to provide a basis for the calculations of Goldberger and Treiman [11] concerning $\pi$-decay, Gell-Mann and Levy postulated that the degree of scattering of the axial vector flow and the field strength of the $\pi$ meson are proportionate. Ogawa pointed out that starting out from the viewpoint of the compound model, the attempt by Gell-Mann and Levy could be realized.

## 5. Kiev Symmetry and the Nagoya Model

B: After the appearance of the compound model, the number of basic particles was considerably reduced. The basic particles of the deuteron class were p, n, and $\Lambda$; those of the lepton class were $\nu$, e, $\mu$; to this was added photons, so that there were seven types in all. Is that correct?

A: Deuterons and leptons all have their anti-particles, and thus there are 13 types in all.

B: What clues do we have about the relationships between these particles?

A: At the international conference called at Kiev in the summer of the year before last (1959), Ma-erh-hsia-k'o pointed out that if we only look at weak mutual interaction, we will discover that there is a startling similarity between deuterons and leptons. And with regard to the following simultaneous substitutions

$$\nu \longleftrightarrow p, \quad e^- \longleftrightarrow n, \quad \mu^- \longleftrightarrow \Lambda$$

there exists a very clear symmetry. We have named this symmetry the

Kiev symmetry because of where it was published. Or in accordance with the names of the discoverers, it is the Gamba-Marshak-Okubo[12] symmetry. In short, this discovery provided an important clue for the discussion of the relationship between the deuteron class and the lepton class.

B: Can the guiding principle of developing the logic of form into the logic of matter be used here?

A: Yes. First of all we put the three basic particles of the deuteron class and the three basic particles of the lepton class into two lines:

$$\begin{array}{ccc} p & n & \Lambda \\ \updownarrow & \updownarrow & \updownarrow \\ \nu & e^- & \mu^- \end{array}$$

Doing this, the Kiev symmetry thus becomes the relationship of the simultaneous substitution of the two lines of particles above and below. In considering the horizontal relationships, we can discover that the just-mentioned complete symmetry exists between p, n, and $\Lambda$. If we take these two symmetries of the logic of form and view them as the logic of matter, then we have our Nagoya Model[13] (note 15).

The Nagoya model is posited thus: If the three leptons are taken as base particles, the adding of the positively-charged $B^+$ matter (note 15) to the base particle produces the basic particles p, n, and $\Lambda$ of the deuteron-meson class. This relationship can be expressed by the following method:

$$p = \langle B^+, \nu \rangle \; ; \; n = \langle B^+, e^- \rangle ; \; \Lambda = \langle B^+, \mu^- \rangle .$$

If we hypothesize that the source of weak mutual interaction is leptons and the source of strong mutual interaction is B matter, then the Kiev symmetry and complete symmetry become almost implicit.

B: All right. If we adopt this viewpoint, then there is no necessity to introduce the imagined space of the type of the isotopic spin space.

A: The main characteristic of our methodology lies in gradually expelling all mystical obstacles from physics. On this point, it may be said that we have continued the tradition of the Mi-li-tu school of ancient Greece. They struggled to oppose making a mythical explanation of nature.

B: If you put it this way, there are similarities. It might be very interesting to compare v, $e^-$, $\mu^-$ $B^+$ with Anaximander's four elements of air, water, soil, and fire.

A: Taketani and Katayama[14] hold that the difference between $\mu$ and e lies in the difference (the Sheng-pao-lo model) in the circumstances of "wrinkling" (the distribution of electrical charge). This explanation is very similar to that of the Mi-li-tu school.

B: Anaximander has already said that if air is concentrated, it becomes water and soil (earth), and if it is dispersed it becomes fire.

6. The Original Appearance of B Matter

B: Can $B^+$ be viewed as positively charged bosons?

A: By no means! It is just because we believe that it may not be such a simple thing that we especially call it B matter. As regards the original appearance of B matter, as to how $\nu$, $e^-$, $\mu^-$ and $B^+$ make up p, n, and $\Lambda$, subsequent research is required. At the present stage, I think things should be as they were on the eve of the proposing of Rutherford's atomic model; various sorts of independent models should be put forward. I imagine this sort of model: $\nu$, e, and $\mu$ are like three different containers, and if B matter is put into these containers, p, n, and $\Lambda$ are produced. Due to the fact that the B matter immediately has energy when put in, if we look at things this way, B matter is perhaps a beer-like thing. In short, no matter what, B matter cannot be grasped within the level of quantum mechanics. Perhaps we can that it is a substance which belongs to a secondary quantum mechanics level.

B: This has been very interesting.

7. The Neutrino Unified Model

A: Finally let us discuss Taketani's Neutrino unified model[15] (note 15). It broadens and deepens our basic particle viewpoint. This was briefly referred to a moment ago in the Sheng Pao-lo (5110 0202 5012) model; the main point of this model is that it says that e and $\mu$ both are charge-carrying $\nu$ (this is called the $\varepsilon$ charge). Their difference simply lies in the different methods of carrying the charge. The neutrino unified model is a combining of the Nagoya model and the Sheng Pao-lo model. The base particle of the Nagoya model is made on the basis of the Sheng Pao-lo model by providing the neutrino with an $\varepsilon$ charge. At that time Taketani proposed that, before the original appearance of B matter of the Nagoya model had been clearly investigated, it might perhaps be an effective method to temporarily consider B matter as a charge-like thing. In actually, Matumoto and Nakagawa[16] successfully utilized this approach to find a basis for Matumoto's mass formula.

B: Putting it this way, if $\nu$ is taken as the starting point and an $\varepsilon$ charge or B charge is added to it, then $e^-$, $\mu^-$, p, n, $\Lambda$ can all be produced. Then what about photons?

A: Taketani holds that photons may be compounded of $e^-$ and $e^+$.

B: In doing research on the neutrino unified model, I feel that our viewpoint on matter will rapidly reach an ultimate point.

A: That would not be correct. The original appearance of the $\varepsilon$ charge and the B charge still require research as matter in the secondary quantum mechanics layer. And "neutrinos are also inexhaustible."

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## Explanation of the "Dialogue on the New Basic Particle Viewpoint"

by Ch'ing Ch'eng-jüi (1987 2110 3843) and Liu Shu-tzu (2692 2885 3320).

### (1) Classical Physics, Classical Model

The physical phenomena which people first studied were those which were easily encountered in everyday like. These were connected with the phenomena of general bodies consisting of billions of atoms or photons, and this did not directly reflect the essence of atoms and photons. Thus these were termed macroscopic physical phenomena. Opposite to this, physical phenomena on the scale of molecules, atoms, or even smaller were termed microscopic physical phenomena.

The study of macroscopic physical phenomena and their laws was termed classical physics. The concepts which described the basic nature of macroscopic physical phenomena were termed classical physical concepts. The theoretical model which was composed of classical physics concepts and which described phenomena of physics was called the classical model.

Classical physics primarily consists of three parts: The first is called classical mechanics. This includes acoustics laws and the laws of the mechanical movements of bodies. The second is called electromagnetism; and this includes optics (kuang-hsueh - 0342 1331), which is a study of the laws of electromagnetic phenomena. The third part consists of thermo-dynamics and classical statistical physics, which is a study of the phenomena of heat and the statistical laws of the movements of systems composed of large numbers of objective bodies.

In the history of modern science, the study of classical physics begins in the 16th century, and virtually concludes in the 19th century. (Many physicists also include in classical physics the theory of relativity which was discovered in the early years of the 20th century.) This was the part of physics which was developed and completed the earliest, and therefore it is called classical physics.

(2) Quantum, the Quantum Theory, Quantum Mechanics, Quantum Electromotive Mechanics, and Quantum Statistical Mechanics

Classical physics was created out of the phenomena of macroscopic physics, and it only serves a function within this sphere. Starting in the last part of the 19th century, scientific research penetrated down to bodies as small as atoms, and discovered that classical physics could not explain the microcosm. This raised the question of establishing a theory which could account for microscopic phenomena.

The energy of things in the macrocosm may be viewed as changing on a continuum. But the internal energy of an atom does not change in this manner; it may only change by leaps. Corresponding to this, the rays which are given off by the atom are not continuous, but are emitted one by one. Each ray may be called a light quantum, or simply a <u>photon</u>. This discontinuity is an important characteristic of the microcosm. The term <u>quantum</u> is used to express this discontinuity of the microcosm.

The <u>quantum theory</u> is a preliminary theory concerning the microcosm which was developed during the first 20 years of the 20th century. It revealed the discontinuous nature of the microcosm, could explain a number of the most simple microscopic physical phenomena, and overturned certain concepts in classical mechanics. And it created conditions for the establishment of later quantum mechanics. However, this was a theory which was obtained by mechanically combining movement principles of a part of classical physics which had not been reformed with conditions of quantization. There was a great limitation to it.

The basic theory formed from a complete reform of classical mechanics which could accurately describe phenomena of microscopic mechanics is called <u>quantum mechanics</u>. The theory formed from a reform of classical electromagnetism which could describe electromagnetic phenomena is called <u>quantum electromotive mechanics</u>. The theory, formed from a reform of classical statistical mechanics which could describe the laws of statistical movements of the systems formed of large numbers of microscopic bodies is called the <u>quantum statistical mechanics</u>. Quantum mechanics, quantum electromotive mechancis, and quantum statistical mechanics were developed from 1925 to 1928.

(3) The Copenhagen School, the Copenhagen Explanation, the Mist of Copenhagen, and the Principle of Complementarity.

The first person to put forward a quantum theory for the structure of the atom was the Danish physicist N. Bohr (1885-1962). He played the guiding role in the development and completion of quantum mechanics. He worked for a long time in Copenhagen, the capital of Denmark. The school, centering around him, which developed theories on microscopic physical phenomena is called the "Copenhagen School." Among these persons was included one of the founders of quantum mechanics, the German physicist W. Heisenberg, etc. The scholarly thinking of this school exerted a great influence among theoretical physicists.

The Copenhagen explanation is the explanation of quantum mechanics given by this school. As stated above, a basic characteristic of the microcosm is its discontinuous nature. For example, in classical concepts there were only wave-like rays and these were composed of one photon after another. Another basic characteristic is that its laws are statistical laws. For example, in classical concepts the movements of kernel-like basic particles all manifest a statistical wave-like nature. The duality of this kernel and wave motion of basic particles could not be accounted for by the classical particle model or by the classical wave motion mouel. In the face of this difficulty, Bohr proposed the principle of complementarity for microscopic phenomena. According to this principle, they held that the kernel nature and the wave motion nature of microscopic bodies could not appear at the same time in experiments. Thus the kernel nature and wave motion nature could never simultaneously exist in microscopic bodies, and they could only supplement one another in understanding.

After refuting the classical model of basic particles, Bohr put forward several idealistic judgments. He held that "due to the quantum nature of interaction, any observation of microscopic phenomena would necessarily bring about a mutual interaction, which could not be overlooked, between the observation instrument and the body. Therefore, with regard to the body and the observation instrument, we could not bestow an independent, actual significance found in standard physics meanings." He said further: "The goal in describing nature does not lie in revealing the actual essence of the phenomenon; it is simply to find to as great an extent as possible the relationships which exists between the various facets of our experiences." In this manner, he expelled objective existence, which does not depend on the subjective, from the realm of science.

The influence of the iddalism and formalism spread among international scholarly circles by the thinking of the Copenhagen school is termed the mist of Copenhagen by professor Sakada Shoichi.

(4) Field, Field Theory, and Quantum Field Theory

Although two charged bodies do not make contact, they can still attract or repel one another. This is because charged bodies can radiate a type of substance which fills up space and they can also absorb this. Under normal conditions, the matter which permeates space cannot be directly felt by human sense organs. By means of exchanging this type of matter, two charged bodies develop a mutual interaction between them.

Thus they mutually attract or repel. This matter radiated by the charged body which fills space is called the electric field. Similar to this, magnetic bodies can also radiate and absorb a type of matter which is called the magnetic field. Later it was discovered that there is a close mutual connection between the electric field and the magnetic field, and they may mutually evolve in the course of movement; thus these were comprehensively termed the electro-magnetic field.

From this time on, when physicists observed mutual attraction or repelling by bodies which were not in contact, they stated that a field existed which acted as intermediary for this mutual interaction. For example, physicists hold that the powerful attraction between the sun and earth is brought about by the intermediary of the gravitational field. The theory which describes the movements and changes of fields is called the field theory. The earliest field theory to be established was the classical electromagnetic field put forward by the English physicist Mai-k'o-ssu-wei in the middle of the 19th century. The theory which describes the macroscopic essence of field is called the classical field theory.

At the start of the 20th century, experiments provided accurate proof which showed that electromagnetic fields are of a discontinuous nature, that they are composed of individual photons. Thereupon, after the establishment of quantum mechanics, physicists altered the classical field theory, and set up the quantum field theory, so as to describe the discontinuous nature of field. This altering of the classical electromagnetic field to form the quantum electromagnetic field theory was the first successful attempt in this reform. The present basic particle theory utilizes the quantum field theory to describe particles; the quantum field is composed of various individual basic particles.

(5) Mathematical Points, the Point Model, Localized Field

In mathematics, the definition of "point" is that it has a position, but no length, breadth, width, or mass. This is a concept which was abstracted from actual life. In order to differentiate this from "points" in actual life, such a point is called a mathematical point.

Basic particles are very small. For the sake of convenience, physicists consider basic particles to be mathematical points with mass. This is the point model of basic particles. The quantum field theory established to describe basic particles which take the point model as its foundation is called the localized field theory, and the corresponding field is called the localized field. In the work of doing research on basic particles, the quantum field theory which is actually used is the localized field theory. For example, the quantum electromotive mechanics is a type of localized field theory.

The present quantum field theory of the localized field is simply a preliminary theory for basic particles, but there are many physicists who take this to be the ultimate theory. In the article these physicists are termed the orthodoxy of the field theory.

(6) The Divergence Difficulty, Correction (chung-cheng-hua -- 6850 2973 0553), the First Type of Mutual Interaction, the Second Type of Mutual Interaction, General Length.

In using the quantum electromotive mechanics to calculate the various basic natures of microscopic electromagnetic phenomena, the first results were in rather good accord with experimental results. But when further more accurate calculations were made, the results obtained were infinitely great in quantity, and consequently were not reasonable. It was later discovered that other localized field theories all contained this theoretical difficulty. This has been labelled the divergence difficulty. "Divergence" is a mathematical concept, and the tending towards the infinitely great is the most frequently seen type of divergence.

In 1947, physicists discovered that the divergences which appeared in quantum electromotive mechanics calculations all stemmed from the fact that the theoretical value of the electron mass and electron charge in the mathematical formulas was infinitely great. If this irrational and infinitely great theoretical value was altered to the limited mathematical value observed in experiments, then the divergences disappeared. This method for getting around the divergence difficulty was called the correction method. Use of this method in quantum electromotive mechanics has been very successful, and the calculation results have been in unusually close accord with the most accurate experimental results. But there are limitations to the correction method, and it is not effective for the mutual interactions of all localized fields. Consequently, physicists have divided the mutual interactions between basic particles into two types: The mutual interactions of basic particles for which the correction method can be used to avoid the divergence difficulty is termed the first type of mutual interaction, and it is also termed the mutual interaction which may be corrected. The type of mutual interaction for which this method is not of value is termed the second type of mutual interaction; this is also termed the mutual interaction which may not be corrected.

In the objective world, there are some physical quantities which may not exceed a certain limit. For example, the speed of mechanical movements can never exceed the speed of light in a vacuum. Also, the minimal unit of rotary motion (the measure of revolving movement) is $\hbar/2$. $\hbar$ is called Planck's constant, and this was introduced into physics by the German physicist M. Planck (1858-1947). Similar to this, Heisenberg held that a minimal unit of length exists, and he called this general length. He held that source of the divergence difficulty in field theory stemmed from the fact that the point model of basic particles did not reflect the existence of this general length.

(7) Basic Particles and Their Classes

Also in the previous century, natural scientists, based on experimental research, set up the theory that matter was composed of very tiny atoms. It this century it was further discovered that atoms are very complex systems. Around atoms in the outer layer many negatively charged small particles -- electrons -- are rotating. At the center of the atom there is the positively charged core, the nucleus. This picture of the structure of the atom was first put forward by the English physicist E. Rutherford (1871-1937). Thus it is called the Rutherford atomic model. Scientists further discovered that the nucleus contains two types of particles, the neutron (n), and the proton (p). Neutrons do not carry a charge, while the protons are positively charged. Because protons and neutrons make up the core of the atom, they are comprehensively called the nucleus.

Of the 30-odd basic particles referred to in the paper, the mass of some of the particles is greater that the mass of the nucleus. The nucleus and particles which are larger in mass than the nucleus are termed deuterons. Of the basic particles, apart from photons, the few particles which are the lightest in mass are the neutrino, the electron, and the $\mu$ particle. These are generally called leptons. The particles which are between the deuterons and leptons in mass are called mesons. (See chart on attached sheet.)

The various basic particles, apart from the differences in their masses, can also be divided into two main classes. Afternally, basic particles are not simple points of mass with not internal movements; rather they are top-like and undertake "self-spin". The physical quantity which expressed this "self-revolution" is the self-spin of particles. It was discovered in experiments that the self-spin of leptons and deuterons is the half whole multiples of $\hbar$ (that is, $\frac{1}{2}\hbar$, $\frac{3}{2}\hbar$, etc.). This sort of particle is called the fermion. The self-spin of mesons and photons is the whole multiples of $\hbar$ (that is, 0, $1\hbar$, $2\hbar$, etc.). This sort of particle is called the boson.

The field which describes the fermion is called the spinor field, and that for the boson is the modulus field.

## (8) The Mutual Interaction and Mutual Changing of Basic Particles

Various sorts of mutual interactions exist among basic particles. Some carry electric charges, and some, although they do not, still resemble small magnetic needles in that they produce a magnetic field. These particles can all directly interact with the electro-magnetic field, or they may interact with each other by using the electro-magnetic field as an intermediary. This sort of mutual interaction is the electromagnetic mutual interaction.

The fine structure constant $\frac{e^2}{\hbar c}$ is the constant which reflects the strength of the electromagnetic mutual interaction. The e in this formula represents the charge of the electron, while the c stands for the speed of light in a vacuum. In the mathematical formulas which express the fine structure of atomic phenomena, this quantity regularly appears, so this is called the fine structure constant.

In the nucleus there exists an extremely strong force of interaction. This is called nuclear force. The nuclear force is much stronger than the electro-magnetic force, so people call this sort of mutual interaction the strong mutual interaction. All mesons and deuterons take part in this strong mutual interaction.

Apart from this, there is another type of mutual interaction. Since this is much weaker than the electro-magnetic mutual interaction, it is called the weak interaction. Apart from photons, all particles take part in this weak mutual interaction.

Since various sorts of mutual interaction exist between basic particles, there can be mutual changes among the particles. For example, a neutron can automatically turn into a proton, and at the same produce one electron and one negative neutrino. The process by which basic particles change into other basic particles automatically is called decay. The decay of particles can be brought about by weak mutual interaction, and by electro-magnetic mutual interaction as well. The decay caused by strong mutual interaction is much more rapid than the previous two, so if a particle undergoes this sort of decay, the particle is definitely especially "short-lived." "Short-life" particles were not included in the 30-odd particles in the article. They have a new name which is called the resonance state or the resonance energy level.

Neutrons and protons may mutually change in the nucleus, and at the same time the nucleus also changes. At this time, we say that the nucleus is undergoing B-decay.

K mesons may also decay. When it decays into a $\pi$ meson, a positron, and a neutrino, we express this decay by using $K_{e3}$.

Particles and anti-particles (negative particles) are completely similar in some aspects, such as mass, self-spin, etc. In some aspects there are completely different, such as charge, magnetic resistance, and singular point (ch'i-i-shu -- 1142 4787 2422), etc. According to this, the positron is the anti-particle of the electron (the positron carries a positive charge, while the electron carries a negative charge); the anti-neutron is the anti-particle of the neutron, the same is true for the neutrino, the $K^-$ meson is the anti-particle of the $K^+$ meson, and so on. When the positive particle and the anti-particle collide, they may turn into other particles; for example, when the fermion collides with its anti-particle, it becomes a photon or a meson. This sort of process is termed the destruction of positive and anti-particles.

The mutual interaction among the basic particles do not simply result in the phenomenon of decay. If two particles collide, the direction of movement of the particles will change, and this is called scattering.

(9) The Nucleus of the Atom

Atomic nuclei may be divided into two classes. One class is stable, and deuterium is a stable atomic nucleus composed of one neutron and one proton. There is another type which is unstable, for they may decay into other nuclei. These unstable ones are called radioactive atomic nuclei. Radium was the first radioactive element obtained by people, and a chemical method was used for this. Its discovery completely smashed the hypothesis that elements could not change, that atoms could not be divided.

The number of the nucleus in the atom is called the mass number of the atom. Based on several masses of nuclei which were observed, the German physicist Wei-cha-k'o discovered a formula, which is called the Wei-cha-k'o mass formula. According to this formula, when one knows the number of protons and neutrons in a nucleus, one can approximately calculate the mass of the nucleus.

The atomic nucleus also has self-spin. Due to the fact that the self-spin of the nucleus of an atom is $\frac{1}{2}\hbar$, the self-spin of atomic nuclei which have even numbers can only by the whole multiples of $\hbar$. The self-spin of those with odd numbers is the half whole multiples of $\hbar$. This is the Law of Odd and Even of atomic nuclei.

When high energy particles bombard atomic nuclei, the nuclei may be smashed into pieces (in actuality these are rather light atomic nuclei), and at the same time a hyperon may be produced (this refers to a deuteron which is heavier than the nucleus.) The newly produced hyperon often stays among the pieces of the nucleus. These pieces are called super-pieces (ch'ao-sui-p'ien -- 6389 4295 3651).

(10) Conservation Quantity, Yu-ch'eng (1342 4468), and the Lack of Conservation of Yu-ch'eng.

Under conditions of no external influence, in the process of observing any movement, we can always discover that there are two types of physical quantities. One type does not change at just any time, and this physical quantity is called conservation quantity. For example, energy and momentum are of this type. The other type does change at any time, and we say that this physical quantity is the process is not conserved. The conservation of a physical quantity, or the lack of it, is determined by the concrete mutual interaction. Yu-ch'eng is a very good example.

In macroscopic phenomena, the laws of movementsof bodies are almost symmetry. This is to say that the laws of movement of a body and of its reflection in a mirror are the same. This symmetrical nature of the laws of movement with regard to space, in the physics of the microcosm, brings about a new physical quantity -- the appearance of yu-ch'eng. This reflects the essence of the approximate symmetry of microscopic particles in space. Before it was discovered that yu-ch'eng is not conserved, people thought that as soon as a microscopic physical system has a certain approximate symmetry, the nature of this symmetry would never change again. And this was the law of conservation of yu-ch'eng. In strong and electro-magnetic mutual interactions, yu-ch'eng is conserved. But in experiments in 1956 it was discovered that in weak mutual interactions, yu-ch'eng is no longer conserved. This is one of the most important discoveries in physics in the past decade.

(11) The Feynman-Gell-Mann Theory

After it was discovered that yu-ch'eng is not conserved, people were uncertain about the concrete theoretical form of weak mutual interactions. After this discovery, the American physicists, Feynman and Gell-Mann, based on experimental facts, put forward a theory which could be universally applied to the process of weak interactions. In their theory they introduced a type of charge exchange flow -- and this was expressed with the symbol $J_{\mu}$. This flow was composed of a charged particle and a neutral particle. This was not an electric current, but part of it was a directional flow, which is very similar to an electric current, so it was termed the vector flow. Another part, which had an approximate symmetry opppsite to the vector flow was termed the axial vector flow. In the movement of the electric current, the quantity of the electric charges does not change, and this is the conservation of electric current. Strictly speaking, this should be termed the conservation of electric charge. Since the vector flow and the electric current are very similar, there should be a law of the conservation of the vector flow.

In the article the $J_{\mu}^{+} \cdot J_{\mu}$ represents the product of two exchange flows; S represents the singular series, and $\Sigma^{+} \rightarrow n + e^{+} + \nu$ is the formula for the positively charged $\Sigma^{+}$ particle decaying into a neutron n, a positron $e^{+}$, and a neutrino $\nu$.

## (12) Isotopic Spin

It was discovered in the laboratory that whether or not the interacting force and the nucleus were charged (whether it was the proton or the neutron) made practically no difference; to this was added the fact that the proton and neutron are practically the same in mass. It was generally held that they were a similar particle, for regardless of the charge or lack of charge of the nucleus, the essence of their strong mutual interactions was completely the same. This nature was termed the independence of charge of nuclear force. It was only due to the fact that their conditions of charge were different, the electro-magnetic mutual interactions were not the same, that there was some difference in the nature of their masses and their interacting force.

The concept of isotopic spin in theory is used to describe the independence of charge of the nuclear force. That which is called "same position" comes from the concept of contrasting isotopės. Isotopes refer to atoms which occupy the same place in the periodic table but which have different masses. Now due to the similarity of position of protons and neutrons in the strong mutual interactions, this term isotope is used. The reason for the term "spin" is due to the similarity between the mathematical tool used and that used to describe the self-spin of the particle. Every particle involved in a strong mutual interaction has a certain isotopic spin.

## (13) Group Theory

Group is a concept of modern mathematics. It is a set of abstract elements which satisfy certain conditions and certain laws of operations.

The group theory is the science of the systematic research on the nature and application of group. In the research on the symmetry of basic particles, the method of group theory is extensively used. San-wei-ma-cheng group is one type of group.

(14) Singular Particles, Singular Series, and the Chung-ye (0022 6851) -- Hsi-t'ao (6007 1497) -- Gell-Mann Law.

After 1947, a number of new particles with strong mutual interactions was discovered. These were the K meson, the $\Lambda$ hyperon, the $\Sigma$ hyperon, the $\Xi$ hyperon, and their anti-particles. They all possessed two singular natures; one was that they were always produced in twos and also that they developed quickly and decayed slowly. These particles were termed singular particles. The nature of these particles was described with the singular series, that is, based on experimental laws, every particle with a strong mutual interaction was provided with a whole number which was called the singular series. In the reactions of strong mutual interactions, the sum of the singular series of all the particles before the reaction was equal to the sum of the singular series of the particles after the reaction. This is the law of conservation of the singular series. Chung-ye, Hsi-tao, and Gell-Mann independently summed up the isotopic spin of the particles with a strong mutual interaction, their singular series, and the relationships between the charge-carrying equivalents. This has become known as the Chung-ye--Hsi-tao-- Gell-Mann law.

The $\Sigma^*$ referred to in the article is a resonance state which has an isotopic spin and singular series the same as $\Sigma$.

(15) The Sakada Model

Professor Sakada Shoichi is a famous Japanese theoretical physicist. He has carried out research on the theory of basic particles for a long time, and he has made important scholarly achievements in this field. In recent years, He has written many philosophical articles on the question of basic particles, propagating the thinking of dialectical materialism. In August of last year, he attended the Peiping science discussion conference as head of the Japanese delegation.

In his research on basic particles in 1942 professor Sakada Shoichi first predicted the existence of two types of neutrinos and two typs of mesons, which were later confirmed by experiments. In 1955, he put forward his famous Sakada Model. This was to explain the nature of the deuteron-meson class, and this opened a way for research on basic particle models in recent years.

Before the discovery of singular particles, Fei-mi and Yang Chen-ning (2799 2182 1337) had already proposed that the $\pi$ meson was composed of a nucleus and an anti-nucleus; this was the Fei-mi -- Yang Chen-ning Model. After the discovery of singular particles, professor Sakada in 1955 proposed that, on the basis of the Chung-ye -- Hsi-tao -- Gell-Mann Law, all particles which had a strong mutual interaction (including singular particles) were composed of the nucleus p, n, and $\Lambda$ particles and their anti-particles $\bar{p}$, $\bar{n}$, and $\bar{\Lambda}$ (see Chart I in the article). This is the Sakada Model. He termed these particles foundation particles, and the model of basic particles built out of these foundation particles is called the compound model.

The Sakada Model holds that the singular series of a particle is the mathematical value of the number of the anti-$\Lambda$ particle contained in the particle minus the number of the $\Lambda$ particle in the particle. For example, in Chart I in the article, the K meson contains one anti-$\Lambda$ particle, but not an $\Lambda$ particle. Thus the singular series of the K meson is $1 - 0 = 1$. In the $\Sigma$ particle there is no anti-$\Lambda$ particle, but there is an $\Lambda$ particle, so the singular series of the $\Sigma$ particle is $0 - 1 = -1$. With this model, it is very natural to use the $\Lambda$ particle number conservation to explain the singular series conservation, for the $\Lambda$ particle number conservation suggests that the differential value of the $\Lambda$ particle number minus the anti-$\Lambda$ particle number does not change.

If the differences of mass and charge for the foundation particles p, n, and $\Lambda$ in the Sakada Model are overlooked, then these may be viewed as the same particle occupying three differing states. This was the complete symmetry introduced by Ikeda, Ohnuki, and Ogawa in 1959. On this basis they used a mathematical met od to undertake a further investigation of the Sakada Model, and they predicted the existence of a $\pi^{0\prime}$ meson with an isotopic spin of zero corresponding to the $\pi$ meson. Later an $\eta$ particle was discovered in experiments, and its nature was in very close accord with the nature of the predicted $\pi^{0\prime}$; the difference between its mass and the value predicted was less than four percent. Apart from this, the nature of the resonance state of a class of mesons recently discovered is in very good accord with the demands of the Sakada Model predictions.

Professor Sakada Shoichi and his colleagues at the Nagoya University are still attempting to make a unified explanation of the nature of the deuteron-meson class and the lepton class, and they have put forward the Nagoya Model. According to their views, foundation particles are composed of base particles. Base particles are $\nu$, $e^-$, and $\mu^-$, and perhaps there is also a type of positively charged $B^+$ matter. If the $B^+$ matter is added to the top of the base particles, they will turn into their corresponding foundation particles. For example, if $B^+$ is added to $\nu$, this will be p; $e^-$ plus $B^+$ is n, and $\mu^-$ plus $B^+$ is $\Lambda$.

In 1959 Taketani and others proposed that of the three base particles $\nu$, $e^-$, and $\mu^-$ it was possible that the $\nu$ was even more basic. If a so-called $\varepsilon^-$ charge was added, this could become $e^-$ or $\mu^-$. The difference between $e^-$ and $\mu^-$ was due only to the difference in the $\varepsilon^-$ charge form. This was the so-called Sheng Pao-lo Model. Not long after, They proposed that the Nagoya Model and the Sheng Pao-lo Model could be combined, that is, that among the base particles $\nu$, $e^-$, $\mu^-$ of the Nagoya Model there existed relations provided by the Sheng Pao-lo Model. This was the neutrino unified model.

The physics of basic particles is an extremely youthful science. It is presently rapidly developing. The Sakada Model has played an important role in the course of the development of the theory on the structure and classification of basic particles. At present the most noteworthy theories on this subject have taken over certain important parts of the theories of the Sakada Model. As for the Nagoya Model and the neutrino unified model, they are still in a state of hypothesis and must await testing by experiments.

Chart of Basic Particle Classes

| 族别 (1) | (2) 带电情况 阳 (3) | 阴(4) | 中(5) | 性 | 阳(3) | 阴(4) | 粒子名称讀音 (6) |
|---|---|---|---|---|---|---|---|
| (8)重 | | $\Omega^-$ | | | $\bar{\Omega}^-$ (尚未发现) (7) | | ouneiga |
| | | $\Xi^-$ | $\Xi^0$ | $\bar{\Xi}^0$ | $\bar{\Xi}^-$ | | kai |
| 子 | $\Sigma^+$ | $\Sigma^-$ | $\Sigma^0$ | $\bar{\Sigma}^0$ | $\bar{\Sigma}^-$ | $\bar{\Sigma}^+$ | xigma |
| | | | $\Lambda$ | $\bar{\Lambda}$ | | | lambda |
| 族 | $p$ | | $n$ | $\bar{n}$ | | $\bar{p}$ | pi,en |
| (9)介 | $K^+$ | | $K^0$ | $\bar{K}^0$ | | $K^-$ | kei |
| 子 | | | $\eta$ | | | | yita |
| 族 | $\pi^+$ | | $\pi^0$ | | | $\pi^-$ | pai |
| 輕(10) | | $\mu^-$ | | | $\mu^+$ | | miu |
| 子 | | $e^-$ | | | $e^+$ | | yi |
| 族 | | | $\nu_\mu$ $\nu_e$ | $\bar{\nu}_e$ $\bar{\nu}_\mu$ | | | niu |
| 光子(11) | | | $\gamma$ | | | | gama |

表中列出的是文中所涉及的35个粒子，其中------线左右的粒子互为正反粒子，习惯上右边的粒子都称为反粒子，反粒子名称字母上大都加上"—"，以示区别。

表中的粒子名称讀音是用汉語拼音字标注的习惯的近似讀音。 (12)

(1) Classes; (2) Circumstances of Electric Charges; (3) positive; (4) negative; (5) neutral; (6) readings for names of particles; (7) not yet discovered; (8) Deuteron class; (9) Meson class; (10) Lepton class; (11) Photons; (12) The chart contains the 35 particles brought up in the article. The particles around the ---line are positive particles and anti-particles (negative particles). By custom, the ones on the right are anti-particles, and they have a "-" added over the letter to differentiate them.
The readings of the particle names are approximate readings made on the basis of the Chinese language romanization system.

- END -

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