About Mechanics of Virtual Reality

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Abstract

Developments of computer science, especially the computer simulation technology, enable us to create a vivid lifelike virtual world, which makes people have experiences both in real and virtual worlds. We have entered a real-virtual mixed age and need new physics to depict such a real-virtual mixed universe. In this article, some personal views about the unification and the future of fundamental physics are proposed. The article contains three parts: (1) **Super Transformation**. Space-Time Transformation with Simulator which describes the space-time transformation between two bodies in two different worlds; in this part, a new picture of nature is plotted to be virtual world net, called Super Universe, on which information can flow from one world to another. (2) **Similarity Mechanics**. A conceptual framework for the unification of fundamental interactions, relativity and quantum in the formulism of fractal geometry and fluid dynamics; in this part, the long range interactions are unified as inverse-square interaction and short range interactions can be regarded as the combination and decomposition of "Rotons". (3) **Artificial Universe**. The physical foundation of artificial reality; in this part, we act as creators to create different kinds of virtual worlds in the formulism of extended cellular automaton at microscopic level and simulation dynamics at macroscopic level.

The result shown here, as a physics theory, is just a beginning, while it greatly deepens our understanding about nature, and provides a new viewpoint and a novel methodology for physics study.

This paper is dedicated to the World Year of Physics 2005 to commemorate the hundredth anniversary of relativity theory and the 50th anniversary of great physicist *Albert Einstein*'s death.

Introduction

Developments of computer science have not only changed our life but also changed our thought. Thanks to the computer simulation technology, we have now been able to create a vivid lifelike virtual world, via which scientists do their researches, teachers do their educations and game players kill their time. All these people have their experiences both in real and virtual worlds. Moreover, in some artworks, especially in the film "*Matrix*"[1], the existence of our world which we call reality have been questioned to be a virtual world controlled by computers; we face the difficulty to tell the world we are living in is virtual or real. In sum, we have entered a real-virtual mixed age and need new physics to depict such a real-virtual mixed universe. Now, we begin our study with the following interesting hypothesis: "if the great physicist, *Albert Einstein*, lived in our age and saw the film '*Matrix*' (Figure 1), what should he tell us?"

Figure 1. *Albert Einstein* sees the file "*Matrix*". The left half is real world and the right half is virtual world. We shall give the space-time transformation between *Einstein* and *Neo*.

I. Super Transformation

(Super general relativity)

Contradiction in Simulation

Suppose a simulation experiment, in which we simulate the running of solar system. We can set the form of the law of gravity at programming time. For example, we can make the gravitational constant smaller than that in our world and we can make it inverse-cube law instead of inverse-square law. Then the speed rate of planet in the simulated solar system is smaller than that in our world. Suppose there is a physicist living in that simulated world. Through long-time observation, he can find the law of gravity of his world. It must be different from the law of gravity of our world: the gravitational constant of the simulated world is smaller and the form of it is inverse-cubed. That's to say, the forms of physical laws are not invariant between the simulated and simulating worlds.

Here we meet a contradiction between two statements: "the two worlds are the same real" and "physical laws are invariant in the two worlds". Which one is right?

Basic Principles

We insist on the former and propose two principles as follows:

1 all the worlds are the same real.

2 simulated event and simulating event coexist.

The former means if one has no enlightenments from other worlds, he cannot tell the world he is living in is virtual or real just as one cannot tell he is moving or resting if he has no reference system, *i.e.*, reality is relative, which is the generalization of general relativity principle, called **Super General Relativity Principle**, and shows the **Relativity of Reality**. For a world, we call it reality or virtuality depends on

whether we are living in it: we call the world we are living in reality, and other worlds virtuality. For example, if we are living in world A, we call it reality and another world B virtuality. While if we transfer our consciousness from world A into world B, then, we shall call world B reality and world A virtuality. Therefore, reality is relative, just as movement is relative; the two worlds are **equal in reality**. Generally, all the virtual worlds are equal in reality and there is no absolutely real world just as there is no absolutely resting reference system. If we insist on the first principle (**Same Real Principle**), we have to give up the proposition that "the physical laws are invariant in the two worlds". Generally, physical laws for different worlds can be different forms, which is a substantial advance of our view about nature that **reality doesn't equal to physical law**.

The second principle states a fact, called **Coexistence Principle**. Nowadays, there are mainly two kinds of simulators available: one is computers; the other is human brains. For computers, suppose there is a glinting ball in the simulated world by a computer, the counterpart of it in the simulating world is the combination of zeros and ones (high and low electrical levels) of the running computer's circuits. In fact, for anything in the simulated world, there is its counterpart (combination of high and low electrical levels of the running computer's circuits) in the simulating world. For human brains, suppose there is a beautiful girl in someone's imagination, the counterpart of it in the real world is the biochemical reactions in his brain. In fact, for anything in one's imagination, there is its counterpart (biochemical reactions) in the real world. In sum, simulated events and simulating events coexist. The second

principle says "simulated events and simulating events coexist", which doesn't mean that simulated events and simulating events exist in the same form. Taking the beautiful girl in someone's imagination as an example, its existing form in the simulated world is a beautiful girl, while the existing form of its counterpart in the simulating world is biochemical reactions.

Super Transformation

Based on these two principles, we deduce the Space-Time Transformation with Simulator (STTS) which is also called Super Transformation.

Let the simulating world be world R (real world), and the simulated world be world V (virtual world). Suppose there is a simulator B in world R which simulates world V. Suppose a body A in R is on the left of B, and it is moving at speed u to right (towards B). In world V there is a body C', which is moving to right (from B) at speed u'. It is illustrated in Figure 2. We shall give the space-time transformation between bodies A and C'.
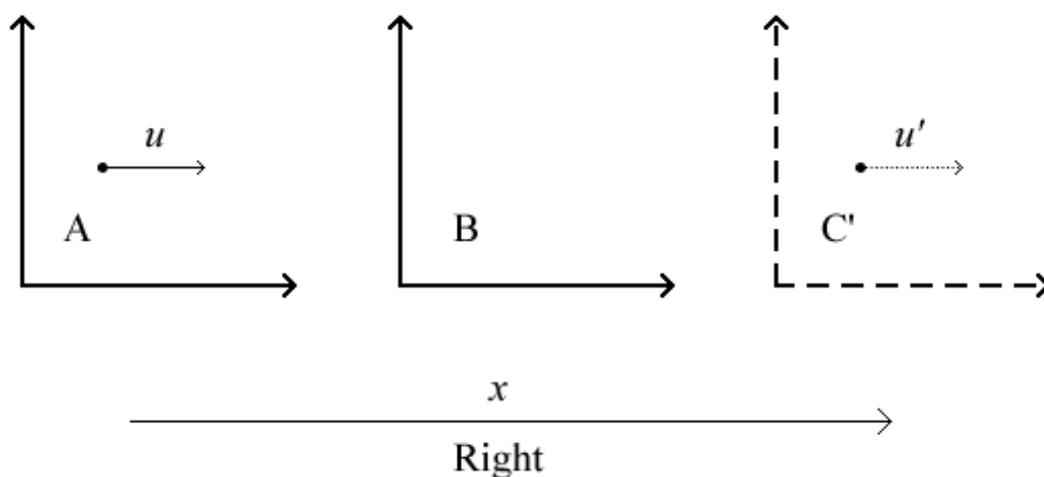

Figure 2. Three relatively moving bodies used to deduce super space-time transformation. B is a simulator. Body A is moving at velocity u relative to B in the real world where B in; body C' is moving at velocity u relative to B in the virtual world simulated by B; The space-time

transformation between A and C′ will be deduced.

According to the first principle, the body A in R and the body C' in V are the same real; therefore, the space-time transformation between them is of meaning.

According to the second principle, there must be a one-to-one map between the simulated events and simulating events, which can be taken as the "tunnel" of simulator through which the two worlds R and V are connected. Suppose the tunnel is symbolized by P. There must be two ends of P: one end is open in R, symbolized by P_R; the other end is open in V, symbolized by P_V. Thus, P_R and P_V are the proxies of simulator B in R and V, respectively. Therefore, the speed u is defined as the velocity of A relative to P_R in world R, and the speed u' is defined as the velocity of C' relative to P_V in world V.

To get the space-time transformation between A and C', we need know the transformation through tunnel P first. Generally, suppose the transformation through the tunnel P of the simulator B is $\hat{P}_B$ and the space-time transformation from A to B in world R is $\hat{T}_{AB}^{R}$ and the space-time transformation from B to C' in world V is $\hat{T}_{BC'}^{V}$, then the transformation from A to C' is:

$$\hat{T}_{AC'} = \hat{T}_{AB}^{R} \cdot \hat{P}_B \cdot \hat{T}_{BC'}^{V}, \tag{1}$$

where "$\cdot$" is the composition of transformations. Equation (1) is the general form of the Space-Time Transformation with Simulator.

In the following, we shall consider the concrete form of STTS under some simple hypothesis. Firstly, consider the transformation between the two ends of the tunnel P. Let the event at P_R be represented by (x_B, y_B, z_B, t_B) and the event at P_V be represented by (x'_B, y'_B, z'_B, t'_B), the length measured at P_V is $\Delta x'$ and it measured at

P_R is Δx. Generally, there is a space scale factor $f_s = \Delta x' / \Delta x$ which is the scale between model and prototype. Suppose the length of tunnel P is 0, which means P_V and P_R are superposed with each other (in "super space"), thus $f_s = \Delta x' / \Delta x = x' / x$, then:

$$x'_B = f_s x_B, \ y'_B = f_s y_B, \ z_B = f_s z'_B.$$ (2)

Suppose an event process. This process lasts $\Delta t'$ in V, and the time for simulating it in R is Δt. Generally, there exists a time scale factor $f_t = \Delta t' / \Delta t$ which is determined by the running frequency of simulator B. Suppose the time to cross tunnel P is 0, which means, for a event process, the time to start simulating it in R is the same time it starts in V, thus $f_t = \Delta t' / \Delta t = t' / t$, then:

$$t'_B = f_t t_B$$ (3)

Merge (2) and (3), we get the transformation through tunnel P:

$$\hat{P}_B = \begin{cases} x'_B = f_s x_B \\ y'_B = f_s y_B \\ z'_B = f_s z_B \\ t'_B = f_t t_B \end{cases}.$$ (4)

By stipulating (if we can) the space unit and time unit of any one of the two worlds, we can set the value of f_s and f_t to be 1 so as to make $\hat{P}_B$ an identical transformation:

$$\hat{P}_B = \hat{1} \ ,$$ (5)

then

$$\hat{T}_{AC'} = \hat{T}^R_{AB} \cdot \hat{T}^V_{BC'} \ ,$$ (6)

which is the space-time transformation between A and C'.

Parity Violation

Look at an example. If the transformation in R is Lorentz transformation[2], then there must be the principle "the light speed is constant" tenable in R. Suppose the light speed in R is c. Then the transformation from A to P_R is:

$$\hat{T}_{AB}^R = \begin{cases} x_B = \dfrac{c}{\sqrt{c^2 - u^2}}(x_A + ut_A) \\ y_B = y_A \\ z_B = z_A \\ t_B = \dfrac{c}{\sqrt{c^2 - u^2}}\left(t_A + \dfrac{ux_A}{c^2}\right) \end{cases} . \qquad (7)$$

If the transformation in V is also Lorentz transformation, then there must be the principle "the light speed is constant" tenable in V. Suppose the light speed in V is c'. Then the transformation from P_V to C' is:

$$\hat{T}_{BC'}^V = \begin{cases} x'_{C'} = \dfrac{c'}{\sqrt{c'^2 - u'^2}}(x'_B - u't'_B) \\ y'_{C'} = y'_B \\ z'_{C'} = z'_B \\ t'_{C'} = \dfrac{c'}{\sqrt{c'^2 - u'^2}}\left(t'_B - \dfrac{u'x'_B}{c'^2}\right) \end{cases} . \qquad (8)$$

Suppose $\hat{P}_B$ can be set to identical transformation:

$$\hat{P}_B = \begin{cases} x'_B = x_B \\ y'_B = y_B \\ z'_B = z_B \\ t'_B = t_B \end{cases} . \qquad (9)$$

Substitute $\hat{T}_{AB}^R$, $\hat{T}_{BC'}^V$ and $\hat{P}_B$ into $\hat{T}_{AC'}$, we arrive at:

$$\hat{T}_{AC'} = \begin{cases} x'_{C'} = \dfrac{cc'}{\sqrt{(c^2 - u^2)(c'^2 - u'^2)}}\left(\left(1 - \dfrac{uu'}{c^2}\right)x_A + (u - u')t_A\right) \\ y'_{C'} = y_A \\ z'_{C'} = z_A \\ t'_{C'} = \dfrac{cc'}{\sqrt{(c^2 - u^2)(c'^2 - u'^2)}}\left(\left(1 - \dfrac{uu'}{c'^2}\right)t_A + \left(\dfrac{u}{c^2} - \dfrac{u'}{c'^2}\right)x_A\right) \end{cases} , \qquad (10)$$

which is the space-time transformation from A to C'.

Take $x'_{C'}$, $y'_{C'}$, $z'_{C'}$ and $t'_{C'}$ as independent variables, and inversely solve the equations in $\hat{T}_{AC'}$, we can get the inverse transformation $\hat{T}_{C'A}$. The formula $\hat{T}_{AC'}$ and $\hat{T}_{C'A}$ represent the space-time transformation between two bodies in two different worlds.

From $\hat{T}^R_{BA}$, we can get the velocity transformation formula $\hat{V}^R_{BA}$ in world R by differential operation. Likewise, we can get the velocity transformation formula $\hat{V}^V_{BC'}$ in world V from $\hat{T}^V_{BC'}$.

Now we consider the relative speeds between A and C'. Suppose the velocity of C' relative to A obtained by $\hat{V}^R_{BA}$ is $v_{AC'}$, the velocity of A relative to C' obtained by $\hat{V}^V_{BC'}$ is $v'_{C'A}$. Because the space-time transformation in two different worlds can be different forms, thus the velocity transformation $\hat{V}^R_{BA}$ and $\hat{V}^V_{BC'}$ are also different generally speaking. Therefore, $v_{AC'}$ is not necessarily equal to $-v'_{C'A}$.

For example, from (7) and (8), we can get:

$$v_{AC'} = \frac{u' - u}{1 - \dfrac{uu'}{c^2}} \tag{11}$$

and

$$v'_{C'A} = \frac{u - u'}{1 - \dfrac{u'u}{c'^2}} . \tag{12}$$

If $c \neq c'$, then $v_{AC'} \neq -v'_{C'A}$.

As a general proposition:

$$v = -v', \tag{Prop. 1}$$

(for two relatively moving bodies, the velocity of A relative to B and the velocity of B relative to A are equal in value and opposite in direction.) is not always tenable in the

transformation between two bodies in two different worlds.

Noticing this, we have to clarify our symbols. The above u is the velocity of A relative to B and should be rewritten as u_{BA}; the above u' is the velocity of C' relative to B and should be rewritten as $u'_{BC'}$.

World Classification

In fact, even for two bodies in one world, we have no enough reason to believe **(Prop. 1)** tenable. In the existent space-time transformations, such as Galilean or Lorentz transformations, **(Prop. 1)** is merely regarded as a priori presumption.

Generally, suppose the space-time transformation from body A to B in a world is $\hat{T}_{AB}$ and the velocity of B relative to A is u_{AB}, that's:

$$\hat{T}_{AB} = \{(x_B, y_B, z_B, t_B) = f(x_A, y_A, z_A, t_A, u_{AB})\}. \tag{13}$$

There are two ways to get $\hat{T}_{BA}$: one is to inversely solve the equations in $\hat{T}_{AB}$, the result is symbolized by $\hat{T}^r_{BA}$, i.e.,

$$\hat{T}^r_{BA} = \{(x_A, y_A, z_A, t_A) = f^{-1}(x_B, y_B, z_B, t_B, u_{AB})\}; \tag{14}$$

the other is to swap the event symbols of $\hat{T}_{AB}$ and substitute u_{BA} for u_{AB}, the result is symbolized by $\hat{T}^s_{BA}$, i.e.,

$$\hat{T}^s_{BA} = \{(x_A, y_A, z_A, t_A) = f(x_B, y_B, z_B, t_B, u_{BA})\}. \tag{15}$$

Which way is right? The former is the direct mathematical calculation and right. The later depends on whether we can get u_{BA} from u_{AB}. In the existent space-time transformations, such as Galilean or Lorentz transformations, u_{BA} is merely presumed as $-u_{AB}$ a priori, which is self-consistent that for Galilean or Lorentz transformations, $\hat{T}^r_{BA} = \hat{T}^s_{BA}$ under the condition $u_{BA} = -u_{AB}$. But if $\hat{T}_{AB}$ is of some

form different from Galilean or Lorentz transformations, $\hat{T}_{BA}^r$ is not necessarily equal to $\hat{T}_{BA}^s$ under condition $u_{BA} = -u_{AB}$.

According to whether the following proposition:

$$\hat{T}_{BA}^r = \hat{T}_{BA}^s \quad \text{if} \quad u_{BA} = -u_{AB} \qquad \textbf{(Prop. 2)}$$

tenable, the worlds can be classified into two classes: Transformation-Symmetric world and Transformation-Asymmetric world, with the former being true of **(Prop. 2)** and the later being false of **(Prop. 2)**. If our world keeps to Lorentz transformation, it is a T-S world.

World Wind

Now we consider the space-time transformation between two bodies with one in T-S world and the other in T-A world. Suppose another example:

$$\hat{T}_{BA}^R = \begin{cases} x_A = \dfrac{1}{\sqrt{1-\dfrac{u_{BA}^2}{c^2}}}\left(x_B - u_{BA}t_B\right) \\[4mm] t_A = \dfrac{1}{\sqrt{1-\dfrac{u_{BA}^2}{c^2}}}\left(t_B - \dfrac{u_{BA}}{c^2}x_B\right) \end{cases} \quad \hat{T}_{BC'}^V = \begin{cases} x_{C'}' = \dfrac{1}{\sqrt{1-\dfrac{u_{BC'}'^2}{c'^2}}}\left(x_B - u_{BC'}'t_B\right) \\[4mm] t_{C'}' = \dfrac{1}{\sqrt{1-\dfrac{u_{BC'}'^2}{c'^2}}}\left(\dfrac{u_{BC'}'}{c'^2}x_B - t_B\right) \end{cases} \qquad (16)$$

Note $t_{C'}'$ in $\hat{T}_{BC'}^V$ which is different from Lorentz transformation, which makes the world keeps to it a T-A world.

From (16) we can get the velocity transformations:

$$\hat{V}_{BA}^R = \begin{cases} v_A = \dfrac{v_B - u_{BA}}{1 - \dfrac{u_{BA}v_B}{c^2}} \end{cases} \quad \hat{V}_{BC'}^V = \begin{cases} v_{C'} = \dfrac{v_B - u_{BC'}'}{\dfrac{u_{BC'}'v_B}{c'^2} - 1} \end{cases} . \qquad (17)$$

Let $c' = 0.5c$, $u_{BA} = 0.3c$, $u_{BC'}' = 0.7c' = 0.35c$, then from (17) we get

$$v_{AC'} = \frac{v_B - u_{BA}}{1 - \dfrac{u_{BA}v_B}{c^2}} = \frac{0.35c - 0.3c}{1 - \dfrac{0.3c \times 0.35c}{c^2}} = 0.0559c$$

$$v_{C'A} = \frac{v_B - u'_{BC'}}{\dfrac{u'_{BC'}v_B}{c'^2} - 1} = \frac{0.3c - 0.35c}{\dfrac{0.35c \times 0.3c}{(0.5c)^2} - 1} = 0.0862c$$

(18)

In (18), the velocity of C' relative to A $v_{AC'} = 0.0559c > 0$ means "from the viewpoint of A, the body C' runs faster than A, and the body A cannot chase up C' (in R)", while the velocity of A relative to C' $v_{C'A} = 0.0862c > 0$ means " from the viewpoint of C', the body A runs faster than C' and the body A can chase up C' (in V)". Here, as for "whether A and C' can meet with each other", body A and body C' have different opinions. It sounds like a paradox but it is true.

Let $c' = 0.5c$, $u_{BA} = -0.3c$, $u'_{BC'} = -0.7c' = -0.35c$, which means the velocity of C' relative to B and the velocity of A relative to B are reversed, then from (17) we get

$$v_{AC'} = \frac{v_B - u_{BA}}{1 - \dfrac{u_{BA}v_B}{c^2}} = \frac{-0.35c + 0.3c}{1 - \dfrac{(-0.3c) \times (-0.35c)}{c^2}} = -0.0559c$$

$$v_{C'A} = \frac{v_B - u'_{BC'}}{\dfrac{u'_{BC'}v_B}{c'^2} - 1} = \frac{-0.3c + 0.35c}{\dfrac{(-0.35c) \times (-0.3c)}{(0.5c)^2} - 1} = -0.0862c$$

(19)

In (19), the velocity of C' relative to A $v_{AC'} = -0.0559c < 0$ means "from the viewpoint of A, the body C' runs faster than A, and the body C' can chase up A (in R)", while the velocity of A relative to C' $v_{C'A} = -0.0862c < 0$ means " from the viewpoint of C', the body A runs faster than C' and the body C' cannot chase up A (in V)". Here, as for "whether A and C' can meet with each other", body A and body C' also have different opinions.

Considering $v_{C'A}$ in (18) and $v_{AC'}$ in (19) simultaneously, we will find a very interesting phenomenon that if all the velocities are rightward, we will see the body A and the body C' meeting with each other in world V, and if all the velocities are leftward, we will see the body A and the body C' meeting with each other in world R, which means "if rightward, A runs faster than C', while if leftward, C' runs faster than A".

Figuratively, it looks like a fat man and a thin man running in wind. If downwind, the fat runs faster than the thin because of his larger volume benefiting more positive wind force; if upwind, the thin runs faster than the fat because of his smaller volume suffering less negative wind force. This wind-like phenomenon originating from the different forms of space-time transformations of two worlds is called "world wind".

Super Universe

In the above deduction, B is a simulator and C' is a body in the simulated world by B. If C' is also a simulator and it simulates another virtual world V'. In V', there is a body D'' moving to right (from C'). What is the transformation between A and D''? Here we generalize STTS to recursive-virtual worlds.

Now consider a virtual world chain:

$$W_1 \rightarrow W_2 \rightarrow \cdots \rightarrow W_n, \tag{20}$$

where "$\rightarrow$" means "there is a simulator in the former world and it simulates the latter world". The arrow "$\rightarrow$" is called "simulation arrow" and represents simulation relation. The world on the left of simulation arrow is called "father world" and the world on the right of simulation arrow is called "child world". Suppose the simulator

in W_1 is S_1, and the tunnel transformation of S_1 is symbolized by $\hat{P}_{S_1}$; the simulator

in W_2 is S_2, and the tunnel transformation of S_2 is symbolized by $\hat{P}_{S_2}$; and so on;

until the simulator S_{n-1} in W_{n-1}, it simulates the world W_n, and the tunnel

transformation of S_{n-1} is symbolized by $\hat{P}_{S_{n-1}}$. Then the transformation between a

body A_1 in W_1 and a body A_n in W_n is the composition of transformations in these

virtual worlds:

$$\hat{T}_{A_1 A_n} = \hat{T}^{W_1} \cdot \hat{P}_{S_1} \cdot \hat{T}^{W_2} \cdot \hat{P}_{S_2} \cdot \cdots \cdot \hat{P}_{S_{n-1}} \cdot \hat{T}^{W_n} . \tag{21}$$

If the transformations of simulators can be set to identical transformation, then (21) is

simplified as:

$$\hat{T}_{A_1 A_n} = \hat{T}^{W_1} \cdot \hat{T}^{W_2} \cdot \cdots \cdot \hat{T}^{W_n} , \tag{22}$$

which is the space-time transformation between two bodies in recursive-virtual

worlds.

There are 3 logical states of virtual world chain:

$$(\cdots W_{i-1} \to W_i \to W_{i+1} \to \cdots) \quad (W_1 \to W_2 \to \cdots \to W_n \to W_1) \quad (W_1 \to \cdots W_i \cdots \to W_n \to W_i)$$
$$\text{(i)} \qquad\qquad\qquad \text{(ii)} \qquad\qquad\qquad \text{(iii)}$$

Here we introduce a concept "super universe". Three logical states of virtual

world chain correspond to 3 basic types of super universe structures. The 1st type is

called "L" (line) type which is opened at two ends. The 2nd type is called "O" (circle)

type which is a closed structure. The 3rd type is call "P" (polliwog) type which is

opened at one end and closed at the other end.

For the 2nd type of super universe, the virtual world chain begins at W_1, when it

reaches W_n, there is a simulator S_n in W_n, and the world it simulates is just W_1.

According to (22), there is

$$\hat{T}_{A_1 A_{n+1}} = \hat{T}^{W_1} \cdot \hat{T}^{W_2} \cdots \cdot \hat{T}^{W_n} \cdot \hat{T}^{W_1} = \hat{T}^{W_1} , \tag{23}$$

thus,

$$\hat{T}^{W_1} \cdot \hat{T}^{W_2} \cdots \cdot \hat{T}^{W_n} = \hat{1} \tag{24}$$

and

$$\hat{T}^{W_2} \cdots \cdot \hat{T}^{W_n} \cdot \hat{T}^{W_1} = \hat{1} . \tag{25}$$

For the 3rd type of super universe, the virtual world chain begins at W_1, when it reaches W_n, there is a simulator in W_n, and the world it simulates is W_i where $1 < i < n$.

According to (22), there is

$$\hat{T}^{W_{i+1}} \cdots \cdot \hat{T}^{W_n} \cdot \hat{T}^{W_i} = \hat{1} \tag{26}$$

and

$$\hat{T}^{W_i} \cdots \cdot \hat{T}^{W_n} = \hat{1} . \tag{27}$$

For the 2nd and 3rd types of super universe, because of the restrictions (24), (25), (26), (27), the transformations in virtual worlds cannot be arbitrary forms.

The existence of super universe structure implies the property of "self-simulation" of the nature which means that the running of the whole super universe can be simulated by a part of one of its worlds. Self-simulation property is the self-similarity of existence. The restrictions (24), (25), (26), and (27) are called "self-simulation restriction". In the above deduction, if V=R, which means the simulated world by simulator B is just the same world B in, then $\hat{T}_{AB}^{R}$ has the same form as $\hat{T}_{BC'}^{V}$. In this situation, the transformations between A, B, C' are just the same as transformations between 3 bodies in only one world.

Now image there are more than one simulator in a world, we will get a picture of super universe to be the virtual world net with simulators being edges, worlds being vertexes, and three basic type "L", "O", "P" structures being leaves (Figure 3), on which information can flow from one world to another. Our world is only a node of super universe. The simulator that our world is running on is called **The Simulator**.
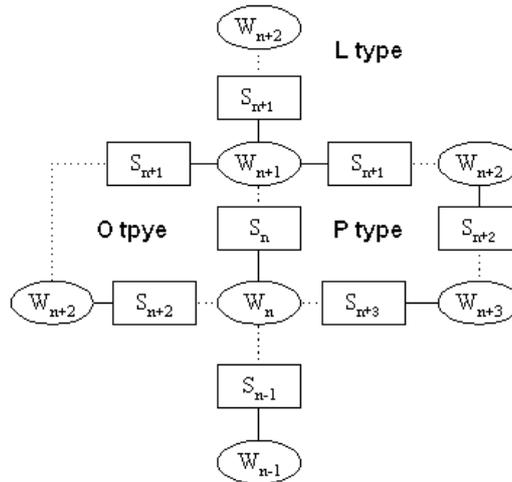

Figure 3. Illustration for (a part of) the structure of super universe. A rectangle represents a simulator and an ellipse represents a world. Solid line represents the relation "contain" which means there are simulators in that world and dotted line represents the relation "simulate" which means the simulator simulates the world. W_{n-1}---S_{n-1}…W_n---S_n…W_{n+1}---S_{n+1}…W_{n+2} is a sample of L type super universe; W_n---S_n…W_{n+1}---S_{n+1}…W_{n+2}---S_{n+2}…W_n is a sample of O type super universe; W_{n-1}---S_{n-1}…W_n---S_n…W_{n+1}---S_{n+1}…W_{n+2}---S_{n+2}…W_{n+3}---S_{n+3}…W_n is a sample of P type super universe. Super Universe is also called "simuverse" (Simulational Multiverse), a world of which is also called "artiverse" (Artificial Universe).

Test Experiments

Here we design two real-virtual mixed experiments to test this theory. One is particle decay and the other is particles chase. Figure 4 is the sketch map for these two experiments.
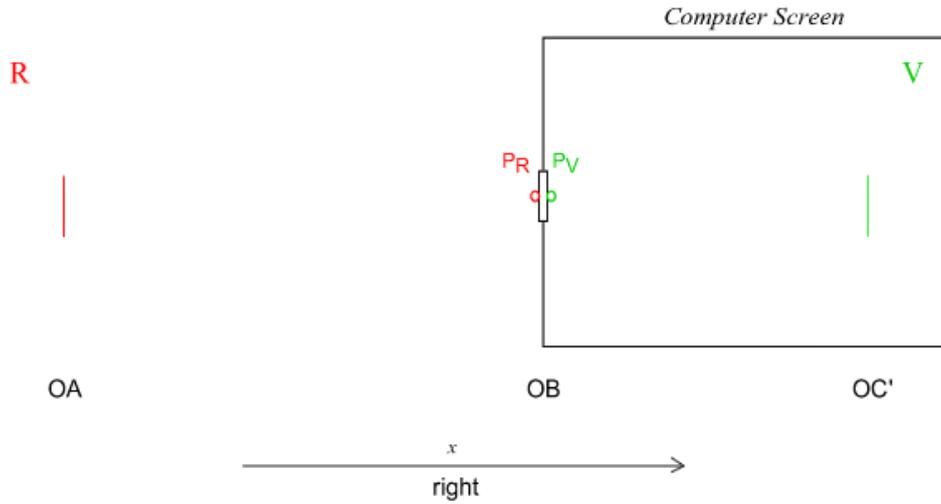
Figure 4. Sketch map for two real-virtual mixed experiments. The red bar at OA is the place to send real particles. The green bar at OC' (on the computer screen) is the place to receive (or send) virtual particles. P_R (red circle) is a target to receive real particles which is connected with a computer on which a simulating program is running to generate virtual particles. P_R is also a device to send real particles triggered by the simulating program when a virtual particle with leftward velocity reaches P_V. P_V (green circle) is the middle point of the left edge of computer screen from where the generated virtual particles begin to run rightward at some a speed.

1. *Particle Decay*

This experiment is designed to test the rightness of composition of transformations (formula 10). Suppose a particle is sent from OA (red bar in R) at a rightward speed u, and the intrinsic life time of it is t_0. The distance between OA and OB is d, and the distance between OB and OC' (green bar on computer screen) is d'. When the particle reaches P_R, a simulating program is triggered to generate a virtual particle in V. it starts moving from P_V (the middle point of the left edge of the computer screen) at a rightward speed u' $(=u)$. The remained lifetime of the real particle is entitled to the virtual particle. Suppose the space-time transformation in V is also Lorentz transformation, but the light speed for it is c'. Now, suppose d' is a constant, the question is how long the distance d should be so as to just receive the

particle at OC'. We can calculate it from formula (10), if it is true of the experiments, then the rightness of the composition of transformations is verified.

2. *Particles Chase*

This experiment is designed to test the rightness of the velocity transformation formula. Let $c' = 0.5c$.

Firstly, we observe the rightward particle chase. Suppose a real particle is sent at speed $u = 0.3c$ from OA, and at the same time (take OB as the reference system), a virtual particle is sent at speed $u' = 0.7c' = 0.35c$ from P_V. According to (18), we should see the meeting of A and C' on the computer screen (in world V).

Secondly, we observe the leftward particle chase. Suppose a virtual particle is sent from OC' at speed $u' = -0.7c' = -0.35c$, and at the same time (take OB as the reference system), a real particle is sent from P_R at speed $u = -0.3c$. According to (19), we can see the meeting of A and C' in the real world.

If in the experiment, such phenomena are observed, the rightness of the velocity transformation formula is verified.

Practical Stories

Story 1. swimming fish and flying bird — a story in nature

Suppose there is a fish swimming in the lake and there is a bird flying in the sky. On the surface of the lake, there is a swimmer (B) with his left eye in water and his right eye in air. Through his left eye, he see the fish (A) swimming towards him to right, and through his right eye, he see the bird (C') flying from him to right. By his left eye, he measured the velocity of the fish relative to him is u, and by his right eye,

he measured the velocity of bird relative to him is u'. Because the velocity in water and that in air all keep to Lorentz transformations, but the light speed in water is not equal to that in air, therefore, the swimmer will tell us that the velocity of the bird relative to the fish is not the opposite number of the velocity of the fish relative to the bird.

Story 2. policeman and thief — a story in future

Suppose in future, man can enter the virtual world simulated by computers owing to the development of man-machine interface technology. Now consider a policeman (A) and a thief (C'). The policeman holds a baton and the thief hold a pistol. There has happened a fighting between them in world R. The thief's pistol has been damaged when they are fighting, but it is not a fatal damage. Any one able to use pistol can fix it in 10 minutes (intrinsic time). Suppose the thief is running to east, when he meets the simulator B, he enters the virtual world V. In the virtual world, the thief begins to fix his pistol. When the policeman arrives at simulator B, if the policeman is clever enough and knows Super Transformation, he should do a calculation before his making decision whether to enter the virtual world or not. Because if the time he runs to the simulator in world R plus the time he runs after the thief until he gets him in world V is longer than the time the thief used to fix his pistol, the policeman doesn't dare to enter the virtual world to catch the thief: Obviously, the baton is not the match of pistol.

Story 3. a contemporary version of story 2 — a story in game

Suppose we hold a real-virtual mixed game. There are two players in this game.

They are all good game players and long-distance runners. But the game we let them play is very ordinary: "policeman and thief". The player A acts as policeman and the player C acts as thief. We plot a game scene as follows:

There are two racetracks in a playground. At the end of the racetracks, there is a computer. The computer is equipped with a large screen which is in the sight of the two players, and two keyboards, each one of which is used by one player. When the players reach the finish line, they begin to contest with each other in computer game: "policeman and thief" (a simple computer game in which the thief runs ahead and the policeman runs after the thief in order to catch him).

The player A (policeman) lets the player C (thief) run first. After a while, the player A begins to run. When the player C reaches the finish line, he enters the computer game by pressing the "Enter" key on his keyboard; at the same time, there is a "thief" (a character in computer game) appearing at the middle point of the left edge of the screen and he begins to run rightward along the horizontal line (to the middle point of the right edge of the screen). When the player A reaches the finish line, he also enters the computer game by pressing the "Enter" key of his keyboard; at the same time, there is a "policeman" appearing at the middle point of the left edge of the screen, and he begins to run after the thief; simultaneously, a computer program starts to simulate the process of "fix pistol".

In this game, the simulator is the computer, and the tunnel P of it is the electro-circuit of the computer, and the end in the real world of tunnel P (P_R) is the "Enter" key on the keyboard, and the end in the virtual world of tunnel P (P_V) is the

middle point of the left edge of the computer screen. The space-time transformation in virtual world V is defined as the transformation between a moving body on the computer screen and the middle point of the left edge of the screen.

We make game rules as follows: if player A enters the computer game and catches the thief, he wins; if the policeman is shot, player C wins; the winner will win 1000 dollars, a half of which is paid by the sponsor (here us) and the other half of which is paid by the loser. But before the player A enters the computer game, if any one gives up, then, the one who gives up pays no money, and the winner will get 500 dollars from the sponsor.

Under such game rules, before the player A entering the computer game, any of the two players should do a calculation and make his decision whether to give up to minimize his loss. In this condition, the one who knows STTS can reduce his losing and increase his winning.

Unification of Three Worlds

ST: *Super Transformation*

Figure 5. Super Transformations bridge three kinds of worlds: objective material world, human mind world and computer simulation world. The three kinds of worlds are unified as virtual realities.

Three kinds of simulators are mentioned above: The Simulator, Human Brains, and Computers. The Simulator is the simulator where our world is running on, which is a "God"-made one. Human brains are the evolution result of our world and

computers are man-made simulators. These three kinds of simulators simulate three kinds of worlds: objective material world, human mind word, and computer simulation world. The three kinds of worlds are bridged by super transformations and unified as virtual realities, which makes it possible to give a uniform description of nature.

Discussions

1. *Virtuality of Existence* Same Real Principle can also be called "ZhuangZi Principle". In ancient China there was a book named "Zhuang Zi"[3]. In the second chapter of that book, the author, Zhuang Zhou, told a story: One day, he was dreaming to become a butterfly. In his dream he absolutely forgot he was Zhuang Zhou, a human being, and only knew that he was a butterfly. Yet, when he waked up, he found himself to be Zhuang Zhou, a human being and not a butterfly. Then, he was puzzled about the question that "was he really a human being but dreamed to be a butterfly, or was he really a butterfly but dreamed to be a human being?" Zhuang Zi might be the first one who realizes the relativity of reality, namely, the virtuality of existence. Therefore, if some one says "we are living in someone's dream", it's no longer a joke.

2. *Reality of Mind* Conduct a thought experiment. Imagine there is a metal ball moving around you. Firstly, imagine it moves clockwise; after some loops, try to make it move anticlockwise as soon as possible; meanwhile, you will feel exerting. Say, you feel clearly that the metal ball in your imagination has inertia, which means it is massive just as a real metal ball. In sum, things in your imagination are the same real as you are.

3. *Reality and Physical Law* Einstein believes that people in different reference systems should feel the same "physical reality", while we beyond him believe that people in different worlds should feel the same "reality". Please note the difference between Einstein and us. Einstein use the term "physical reality", we use "reality". That's to say, the same reality doesn't means the same physical law,

i.e., "reality" doesn't equal to "physical law", which is a substantial advance of our view about nature. Einstein, limited to his age, cannot realize the difference between reality and physical law. But nowadays, thanks to the development of simulation technology, we can create a virtual world with different physical laws from ours. We have been playing the role of "God", maybe only partially, but this fact will enable us to greatly deepen our understanding about nature.

4. *Information Conservation Law* In the picture of super universe, body's translation from one world to another, actually, is the representation of the body in different worlds. A transformation action corresponds to a recreation procedure. "Body C transfers from world A to world B" means the recreation of body C in world B (using the elements of world B) according to the information carried by body C. Ensuring body C to be body C must require the conservation of information.

5. *Consciousness* Suppose in future, man can enter the virtual world simulated by computers owing to the development of man-machine interface technology. If consciousness can be transferred from one world to another, its essence may be information. That is, the essence of consciousness is information flow, is the running of human brain as a simulator. Furthermore, simulation relation also joints the subjective world and objective world, which enables a uniform description of nature.

6. *Free Will* Free Will is the correlation of two worlds with different physical laws. There are two necessary factors for Free Will: Difference and Correlation. Owing to difference, the physical laws in one world (typically the simulating world) cannot determine all the phenomena in the other world (typically the simulated world), which ensures that there is room to accommodate Free Will. If the two worlds have the same physical laws, they can be taken as one bigger world, and therefore there is no room to accommodate Free Will. Owing to correlation, Free Will can be manifested. If there is no correlation between the two different worlds, one can only lives in either this world or that world, which is just like there is only one world, and therefore Free Will cannot be manifested. We have free will just because we are living in a superposed state of two different worlds (here

"different" means the two worlds have different physical laws), i.e., we are living in both reality and imagination. If we just live in one world, we won't have free will; and even we have, it cannot be manifested. Both the two factors are necessary to ensure the existence of our free will.

7. *Super Universe* Super universe is a kind of vertical structure of multiverse (may be called "vertiverse") in comparison to the parallel structure of multiverse such as in the multi-world interpretation of quantum mechanics.

<div align="right">(Feb. 20, 2005)</div>

II. Similarity Mechanics

<div align="center">(Special super general relativity)</div>

Super general relativity theory based on "same real principle" and "coexistence principle" unifies conceptually three worlds: objective matter world, subjective mind world and computer simulated world and gives a new plot of nature as virtual world net called Super Universe. While as for a concrete node of super universe, especially for the world we are living in, it does not unify its physical laws, thus it is incomplete. Since physical laws in different worlds can be different forms, the physical laws in one world should be in the same form. Based on this idea, we proposed Special Super General Relativity Theory as a special case of super general relativity in which same real principle and coexistence principle are applied to one special node of super universe, i.e., our world. Special super general relativity theory aims at unifying the physical laws of different existence scales, so it may also be called "Scale Relativity Theory".

Basic Principles and Matter Structure

Relativity of Measurement all of our knowledge about quantity are from measurement. Measurement is a procedure of comparison where a measure unit is taken as a standard to be compared with the object to be measured and the quantity of this object is determined according to the number that this object contains the measure unit. The property of measurement that a measure unit is always taken as a reference is called the "relativity of measure". Here measure includes the measure of space, time, speed and energy. The relativity of measure means that big or small (of space), short or long (of time), fast or slow (of speed), high or low (of energy) are all relative. A human's body is smaller than a mountain but bigger than an ant; a human's lifespan is shorter than a tortoise but longer than a fly; a human runs slower than a leopard but faster than a snail; a human has more power than a rabbit but cannot pull back an elephant. All the above examples demonstrate that big or small, long or short, fast or slow and high or low (of energy) are all relative. The key is to see the measure of the object as standard (reference), or namely, the relative scales of the two objects for comparison.

From the "relativity of measure", it can be deduced that the matter structure is infinitely divisible. Proof is as follows: because measure is relative, there is no absolute bigness or smallness; if the matter structure is not infinitely divisible, there must exist absolute bigness or smallness, which contradicts the "relativity of measure"; so the matter structure is infinitely divisible.

Basic Principles

1. Same law principle: all the existence scales keep to the same physical laws;

2. Statistics principle: macro state and micro state coexist.

(**Same Law principle** and **Statistics principle** are special forms of **Same Real principle** and **Coexistence principle**, respectively.)

According to the above "relativity of measure", an infinitely divisible matter structure is obtained. While what is the relationship between matter structures at different existence scales? And what is the relationship between the laws that they keep to? Same law principle tells us that matter structures at different existence scales are similar to each other because they keep to the same physical laws. Then, we can know that if we take human beings' existence scale as the center, there are infinite numbers of "big human" worlds upward and among them the one who takes solar system as an atom is the nearest world from ours along the direction of big scale, and from now on, if we say the "big human world" without otherwise statement, it is default as this world. Likewise, there are infinite numbers of "small human" worlds downward and among them the one who takes an atom as the solar system is the nearest world from ours along the direction of small scale, and from now on, if we say the "small human world" without otherwise statement, it is default as this world. Therefore, the matter structure of our universe is an infinitely divisible fractal.

According to the self-similarity of a fractal, we know that particles at any existence scales have a structure like solar system or atom, i.e., the "nucleated-revolving" structure. At the same time of space scaling, the time is also scaling. That's to say, the time unit used in the small human world is shorter than that of our world whilst the time unit used in the big human world is longer than that of our world. But

the scale for space scaling and that for time scaling is not the same, therefore, the light speeds in different scale worlds are not the same. Suppose the light speed in our world is c, then the light speed in the small human world is larger than c (may be c^2) called "fast light" and the light speed in the big human world is less than c (may be $\sqrt{c}$) called "slow light".

However, the human beings in big human world do not feel the so-called (by us) "slow light" in their world is slow because all of the processes in their world are slowed; and thus the speed of "slow light" is still the fastest speed in their world. We say the speed of "slow light" slow just because we take the light speed in our world as a reference. Likewise, the human beings in small human world do not feel the so-called (by us) "fast light" is fast because all the processes in their world are fasted. For an existence scale, the light speed of that scale is the fastest signal speed for that scale which makes the interactions local seen in that scale.

Special coexistence principle (Statistics principle) indicates that there are two scales for the description of physical phenomena: macroscopic and microscopic. And there exists a scale transformation able to transform the description of microstate to macrostate. Therefore, special super general relativity theory can also be called "Scale Relativity".

Unification of "Fundamental" Interactions

Since 30's of 20th century, human beings' exploring frontier of micro world has been boosted into the field of particle physics. At the beginning of 1960's, thanks to the development of the building technologies of big accelerators, a large quantity of

new "elementary particles" has been found. Till then, five forces came into human sight, i.e., electrostatic, magnetic, gravitational, strong nuclear and weak nuclear forces. Among them, electrostatic and magnetic forces had already been unified by Faraday/Maxwell as electro-magnetic force[4]; the electromagnetic force and weak nuclear force were unified through QED, Feynman rules, symmetry, group theory, gauge theory & renormalization *etc.* (by Glashow, Weinberg, Salam, *et al.*) as electro-weak force[5]; on similar lines with quantum-chromodynamics (QCD), the strong force is further considered to be unified, leading to the so-called Standard-Model[6-8].

Standard Model believes that there exist four fundamental interactions in the nature: strong, weak, electromagnetic and gravitation, and three kinds of elementary particles: gauge-bosons, fermions, and maybe higgs. Great Unification Theories (GUT) are just those theories aiming at unifying the different particles and interactions in different existence scales, and String/Membrane theory and its variant Supergravity/quantum-gravity theory are representatives of GUT[8]. However, can these interactions be unified? And how can it be done?

Inverse-Square Law The form of fundamental interaction is determined by the dimension of the space. The only reasonable form of interaction in 3D space is inverse-square law. Proof is as follows:
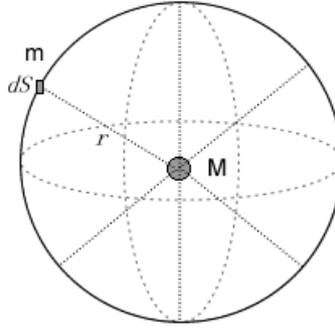
Figure 6. Inverse-square force as a result of the decrease of meson flow areal density. The area of the spherical surface $4\pi r^2 \propto r^2$, therefore the areal density of meson flow $\propto 1/r^2$, which is the origin of inverse-square force.

As shown in Figure 6, suppose the interaction between two bodies M and m are realized by exchanging meson flows; a body's ability of sending and receiving mesons proportions to its matter quantity; and the interaction strength accepted by a body proportions to the meson numbers that it receives.

Then the meson flow sent by body M uniformly diffuses to different directions in the 3D space, and then the frontier of this flow is a sphere. Therefore, the area of the front sphere of this meson flow increases with the increase of the square of propagation distance r, resulting in the areal density of the meson flow on the front sphere decreases with the square of propagation distance r. Then, the meson numbers received by a unit quantity of matter decrease in proportion to the square of r. And thus there is:

$$F = K \frac{Mm}{r^2} \tag{a}$$

This is just the form of inverse-square law where K is a constant to be measured by experiment.

An important view of special super general relativity is that the form of fundamental interaction is determined by the dimension of the space. In the above

deduction, three principles are referred: (1) **Locality principle**. That is, the interactions are local ones and realized by exchanging mesons with finite speeds. There is no instant interaction acting at a distance. (2) **Simplicity principle**. That is, the strength of interaction linearly proportions to the matter quantity. (3) **Symmetry principle**. That is, different directions of our space are symmetric with each other and space is isotropic. In 3D space, the formula who keeps to the above three principles is only inverse-square law (a). Similarly, the formula who keeps to the above three principles in 2D space is only the inverse-linear law while that for 4D space must be inverse-cubic law. And so on.

Gravitation and Electrostatic Force They are all inverse-square interactions and essentially the same interaction but appearing at different scales, and thus they are relative. The so-called "gravitation" by us is the electrostatic force for big human; and the so-called electrostatic force by us is gravitation for small human. Therefore, it can be predicted that there must exist anti-gravitation (repulsive force). Galaxies composed of matter and those composed of antimatter must be repulsive to each other so that our solar system is not attracted by other solar systems composed of antimatter and collides and annihilates. For big human, our solar system is just like an atom and sun is the nucleus and the planets are just like electrons. When the planets jump between the orbits running around the sun, slow light is emitted which is the light wave in the big human world and the speed of it is less than c (suppose c is the light speed of our world). Likewise, from the viewpoint of small human, our atom is just like the solar system of their world and the nucleus is the sun and the electrons are the

planets. Communication between the nucleus and electrons are like the process of the sun throwing light to the earth. Therefore, the communication between nucleons and electrons is conducted by the "fast light", i.e., the light in small human world.

Strong and Weak Forces Essentially speaking, they are not interactions but reactions. Because strong and weak interactions only manifest in nuclear reaction or particle decay reaction, thus their essence are reactions just like chemical reactions. Because there is only one fundamental interaction— inverse-square interaction —in 3D space which is a long range interaction, the short range properties of strong and weak interactions prove them to be **reactions** not **interactions**. Thinking that strong and weak interactions have equivalent positions to gravitation and electricity to be the fundamental interactions of our world is a wrong thinking. Their short range properties just prove that they are not interactions but reactions just like chemical reactions. Like in chemical reactions where two atoms must approach to each other very close so that the electron orbits of the two reacting atoms are superposed with each other to incur chemical combination, two nucleons can only react with each when they are near enough so that the orbits of the **nucleons' electrons** can superpose with each other (see Figure 7). Just as we do not regard chemical reaction as fundamental interaction of our world, we should not regard nuclear reaction and particle decay reaction as fundamental interaction. By the analogy between particle table and chemical element table, we are convinced that the essence of strong and weak interactions is reaction not interaction.
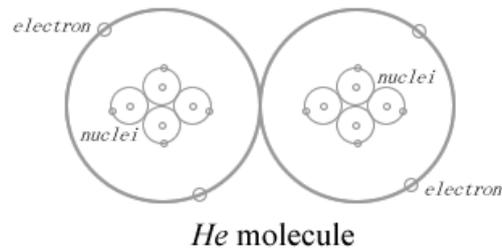
He molecule

Figure 7. Schematic illustration of "nucleus in nucleus" structure of particles.

In a summary of the above, we know that there is only one fundamental interaction in 3D space and that is inverse-square interaction which is a long range interaction. Any short range "interaction" is essentially reaction. In the fundamental interaction, fermions are the agents and bosons are the media. Higgs particles do not exist.

Conciliation of Relativity and Quantum

As two cornerstones of the physics building of twenty century, Relativity Theory and Quantum Mechanics have achieved glorious triumph in their own applicable fields, respectively. But there are deep contradictions between them. The contradictions between relativity and quantum mainly reflect at two points: (1) certainty and uncertainty. Relativity is rigorously a theory of certainty. Einstein persists stubbornly in that "God doesn't play dice", while quantum shows some intrinsic uncertainty such as the Heisenberg's uncertainty relation; (2) locality and nonlocality. Relativity is rigorously a local theory and believes that there is the maximum signal speed while quantum demonstrates some nonlocal correlation such as in entanglement.

These diametrically opposed contradictions disturb physicists deeply so that many people believe that one of them must be wrong. However, is this really so? Here we

shall tell that the contradictions between relativity and quantum are phenomenological although they seem profound, and relativity and quantum can be unified under the framework of **Scale Relativity**.

We shall begin with the **uncertainty effect** of quantum. Here we say uncertainty effect instead of uncertainty principle is aiming at emphasizing that the uncertainty is only a kind of effect rather than a principle. Just as space contraction and time dilation in special relativity are effects of **motion relativity**, uncertainty is some kind of effect of **scale relativity**. We cannot determine the position of an electron but we can accurately measure the orbit of a planet. This fact tells us that whether or not we can obtain a precise measure depends on the relative scale of the observer and the object to be observed. From this fact, it can be deduced that small human must be able to accurately measure the position of an electron because an electron looks as big as a planet in their eyes. Likewise, the orbit of our earth must be unable to be accurately measured by big human just like we cannot do it to an electron. Therefore, whether or not an object can be accurately measured is relative, thus, certainty and randomness (uncertainty) is relative. There is no absolute certainty and randomness just as there is no absolute motion and rest. So the uncertainty of quantum does not contradict the certainty of relativity.

Now see the locality and nonlocality. They are also relative. As aforementioned, two particles (such as an electron and a proton) that rest relative to each other communicate by "fast light", *viz.* the light in small human world. Therefore, the interaction between two particles with non-local correlation seen from our world may

be local one seen from the small human world. We think the correlation is non-local because the meson speed that connect the two particles surpasses the light speed of our world while small human think the correlation is local because the meson speed that connect them does not surpass the light speed of their world. Likewise, the local interactions seen from our world may be non-local ones seen by big human. Just because the maximum signal speeds at different existence scales are different, the non-local interactions seen from a scale may be local ones when seen from a smaller scale; likewise, the local interactions seen from a scale may be non-local ones when seen from a bigger scale. Therefore, to be local or non-local is relative. There is no absolute locality and nonlocality just as there is no absolute motion and rest. So the nonlocality of quantum does not contradict the locality of relativity and is just some kind of effect of **Scale Relativity**.

Now we see another manifestation of quantum: Discreteness. "Discreteness" and "Continuity" is a pair of relative concepts. That is, a discrete phenomenon seen from a scale may be continuous seen from another scale and vice versa. For example, asphalt road surface is rugged seen by ants but smooth for a van tire. Discreteness is only observable at specific scale. For a bigger scale, it seems continuity due to the rough resolution of the apparatus. For a smaller scale, it is unobservable due to too large span of intervals (even longer than the human activity scope and history of that scale). Therefore, there is no absolute discreteness and continuity just as there is no absolute motion and rest. The difference between discreteness and continuity is only a kind of effect of **Scale Relativity**.

About Superluminal Speed For every existence scale, there is a maximum signal speed which is the light speed of that scale. For a scale, the light speed of that scale cannot be surpassed whilst for a smaller scale, there is a faster light speed (the speed of "fast light" seen from the former scale). The smaller the scale is, the faster the light of it runs. Therefore, whether a light speed can be surpassed or not is relative. For every existence scale, it cannot surpass the light speed of its own scale, while for a smaller scale, the light speed of that scale is not a limit. The existence of maximum signal speed is also a kind of effect of **Scale Relativity**.

About Minimum Quantum of Action It is believed that Planck constant stipulates the minimum quantum of action of our world. However, because of the **relativity of measure**, for a bigger or smaller existence scale, it is not the minimum quantum of action. The smaller the scale is, the higher the energy density. Therefore, the minimum quantum of action only has a relative meaning; it is only meaningful at a specific existence scale; the existence of it cannot be taken as a reason for denying the infinitely divisible nature of matter structure.

The Essence of Matter Wave

What is matter wave? And what is wave function. Making a clear comprehension for matter wave and wave function in quantum mechanics is another difficult problem disturbing physicists deeply. Here we shall give the answers. The essence of matter wave is the motion trajectory of the position center of a "nucleated-revolving" system in 3D space, i.e., a wave-like motion of position center; and meanwhile it is also the wave-like character of the systematic action of a "nucleated-revolving" system. While

the wave function in quantum mechanics is an artificial (man-made) description of the systematic action of the "nucleated-revolving" system as an empirical formula and essentially is an approximation of the wave character of the systematic action in Hilbert space. The module square of wave function reflects the distance between some position in the space (at some time) and the position center of the "nucleated-revolving" system and proportions to the probability to find the "nucleated-revolving" system at that position. Proofs are as follows:
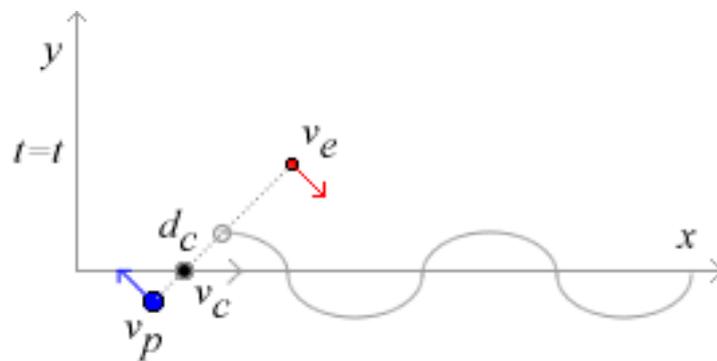

Figure 8. The trajectory of the position center of a moving "nucleated-revolving" system is wave.

As illustrated in Figure 8, suppose there is a free "nucleated-revolving" system (a free particle) with a mass center velocity of v_c. Here "free" means there is only the interaction between the nucleus and the peripheral particle (internal force) and no external forces acting on the "nucleated-revolving" system. Under such a condition, the system should rotate around their common mass center and the momentum and energy and the angular momentum of this system all conserve in the moving. Suppose the distance between the nucleus and the mass center is d_p and the distance between the peripheral particle and mass center is d_e, then the distance between the nucleus and the peripheral particle is $d = d_p + d_e$. Suppose the angular velocity of the system

revolving around their mass center is ω, the linear velocity of the nucleus running around the mass center is v_p and the linear velocity of the peripheral particle running around the mass center is v_e, then there is $\omega = \dfrac{v_p}{d_p} = \dfrac{v_e}{d_e}$. Taking the direction of the velocity of the mass center as the positive direction, the coordinate frame is established, and then the vertical coordinate y of the mass center is always zero. The position center of the "nucleated-revolving" system is defined as the middle point of the line between the nucleus and the peripheral particle. Suppose the distance between the position center and the mass center of the system is d_c, then $d_c = \dfrac{d_e - d_p}{2}$. Suppose the mass of the peripheral particle is m_e and that of the nucleus is m_p and there is $m_p = km_e = km$. Now we deduce the trajectory of the position center of this "nucleated-revolving" system.

Suppose the coordinates of the peripheral particle are $x_e(t)$ and $y_e(t)$. Because the velocity of the mass center v_c is along the positive direction of x coordinate, the trajectory of the peripheral particle is:

$$\begin{cases} x_e(t) = d_e \cos(\omega t) + v_c t \\ y_e(t) = d_e \sin(\omega t) \end{cases}. \tag{28}$$

Suppose the coordinates of the nucleus are $x_p(t)$ and $y_p(t)$, then there is:

$$\begin{cases} x_p(t) = -d_p \cos(\omega t) + v_c t \\ y_p(t) = -d_p \sin(\omega t) \end{cases}. \tag{29}$$

From (28) and (29), the coordinates of the position center of this system is:

$$\begin{cases} x_c = \dfrac{1}{2}\left(x_e + x_p\right) = \dfrac{1}{2}\left(d_e - d_p\right)\cos(\omega t) + v_c t \\ y_c = \dfrac{1}{2}\left(y_e + y_p\right) = \dfrac{1}{2}\left(d_e - d_p\right)\sin(\omega t) \end{cases}. \tag{30}$$

Substitute $d_c = \dfrac{d_e - d_p}{2}$ into (30), we get:

$$\begin{cases} x_c(t) = d_c \cos(\omega t) + v_c t \\ y_c(t) = d_c \sin(\omega t) \end{cases}.$$ (31)

This is the parameter equation of the trajectory of the position center of the "nucleated-revolving" system.

From (31), we know that if the mass of the two parts of the "nucleated-revolving" system (i.e. the nucleus and the peripheral particle) equals, then the position center and the mass center of the system are superposed with each other and $d_c = 0$, and thus there shows no wave character of this system; otherwise, if the mass of the two parts of the "nucleated-revolving" system does not equal to each other, then the position center and the mass center of the system do not superpose with each other and $d_c \neq 0$, and thus the trajectory of the position center is a wave. Generally speaking, the mass of the "nucleated-revolving" system is largely centralized on the nucleus. So the position center does not superpose with the mass center and there shows the wave character of the system.

Uncertainty Relation The distance d between the two parts of the "nucleated-revolving" system is the span of the system in the position space and represents the uncertainty degree of the position of the system; the relative speed $v = \omega d$ is the span of the system in the velocity space and represents the uncertainty degree of the velocity of the system. When the uncertainty degree of the velocity is multiplied by the mass of the system, it represents the uncertainty degree of the momentum of this system. According to the definition and conservation of angular

momentum, we get:

$$L = m\omega d^2 = d \cdot m\omega d = \Delta r \cdot \Delta p = \text{constant} . \qquad (32)$$

From (32), we know that the uncertainty of position and the uncertainty of momentum have a relation of one growing and the other declining. That is, the smaller the uncertainty of position, the bigger the uncertainty of momentum; and vice versa. This is just the meaning of Heisenberg's uncertainty relation. Therefore, the uncertainty relation is a result of angular momentum conservation.

Seen from another viewpoint, it is also a result of energy conservation of the "nucleated-revolving" system. Because the inner force of the system is a conservative attractive force, the longer the distance between the two parts of the system (namely, the bigger the uncertainty of position), the higher the percentage of the system's potential energy and the lower the percentage of the system's kinetic energy (namely, the smaller the uncertainty of the momentum); on the contrary, the shorter the distance between the two parts of the system (namely, the smaller the uncertainty of the position), the lower the percentage of the system's potential energy and the higher the system's kinetic energy (namely, the bigger uncertainty of the momentum). In one word, the system's position uncertainty and momentum uncertainty have a relationship that one grows and the other declines.

Readers who are familiar with the deduction procedure of the uncertainty relation from the wave function of quantum mechanics[9] should feel the conciseness of the deduction here. To obtain the uncertainty relation from the wave function of quantum mechanics needs a long and tedious deduction procedure, and the explanations for this

relation are even more strange and elusive[10]. Taking the orthodox explanation given by Heisenberg himself as an example, he thinks that uncertainty comes from the disturbance from the instruments to the system to be measured. Later, his this idea has been developed to the function of human's consciousness, sinking into subjective idealism.

From the above deduction, we know that the uncertainty relation is a necessary result of the conservation of the angular momentum (or energy) of a free "nucleated-revolving" system. The deduction procedure is simple and the physical meaning is clear.

The Wave Character of Action By differential operation on equation (31), the velocity of position center is obtained:

$$\begin{cases} v_{g_x} = -d_c \omega \sin(\omega t) \\ v_{g_y} = d_c \omega \cos(\omega t) \end{cases} . \tag{33}$$

Then the action of position center is:

$$\begin{aligned} S_c &= \vec{p} \cdot \vec{r} - E \cdot t = m_c \vec{v}_g \cdot \vec{r}_g - E \cdot t = m_c \left[v_{g_x} r_{g_x} + v_{g_y} r_{g_y} \right] - \frac{1}{2} m_c v_c^2 t \\ &= m_c \left[\left(-d_c \omega \sin(\omega t) + v_c \right)\left(d_c \cos(\omega t) + v_c t \right) + d_c^2 \omega \sin(\omega t)\cos(\omega t) - \frac{1}{2} v_c^2 t \right] \\ &= m_c \left[d_c v_c \cos(\omega t) + d_c v_c \omega (1 - t)\sin(\omega t) + \frac{1}{2} v_c^2 t - \frac{1}{2} d_c^2 \omega^2 \right] \end{aligned} \tag{34}$$

where $m_c = (k+1)m$ is the total mass of the whole system.

From (34) it can be seen that the action of the system waves with time t. Comparing (34) with Schrödinger's wave function for a free particle:

$$\psi(r,t) = A e^{\frac{i}{\hbar}(p \cdot r - E \cdot t)} = A e^{\frac{i}{\hbar}S} , \tag{35}$$

it can be found that the wave in Schrödinger's equation is an approximation of the

wave of the action of a "nucleated-revolving" system in Hilbert space. The original intention of Schrödinger's establishing wave equation is to study the atom structures with a new idea of wave motion. He made an analogy between free particle and plane wave and introduced artificially an imaginary exponential function to make the action of a free particle wave so that the stability of atom structure can be explained by the aid of a concept similar to standing wave. While the cost for this doing is dragging the wave in 3D real space into a mysterious complex space. As for the Planck constant in wave function (35), it is a reflection of the precision of our apparatus under the present ability of measurement. Now we have known the essence and origin of matter wave, we do not need Schrödinger's wave equation any longer in principle. Nevertheless, as a set of empirical formulas, the formulism of quantum mechanics is still valuable in dealing with some practical problems.

Distance Function Equation (31) is the parameter equation of the trajectory of position center of a "nucleated-revolving" system. For a given time t, it gives the average position of the "nucleated-revolving" system in the space. Therefore, we can define a distance function:

$$
\begin{aligned}
d(x,y,t) &= \sqrt{(x-x_c)^2 + (y-y_c)^2} \\
&= \sqrt{(x(t)-d_c\cos(\omega t)+v_c t)^2 + (y(t)-d_c\sin(\omega t))^2} \; . \\
&\approx \propto 1 - |\psi(x,y,t)|^2 = 1 - \psi^*\psi
\end{aligned}
\tag{36}
$$

It represents the distance between the position (x, y) and the position center of the "nucleated-revolving" system and reflects the probability to find the system at position (x, y) and approximately proportions to the module square of Schrödinger's wave function.

The position center of a "nucleated-revolving" system represents the position of the whole of this system. Equation (31) shows that there is a certain position of the position center of the system at time t and the probability of finding this system at position (x, y) negatively proportions to the distance from the point (x, y) to the position center of the "nucleated-revolving" system. Because the nearness or farness of the distance is relative, the probability to find the position center of the "nucleated-revolving" system at some position does not change when the distance function multiplied by a constant (it is equivalent to changing the measure unit of the distance). So the wave function can be normalized.

By now, we know that the relativity of farness or nearness of distance is the foundation that the wave function of quantum mechanics can be normalized and we also know that the distance function is the essence of the target of Born's interpretation for wave function. In addition, we need notice that the position center is just the position center; it only gives the position of the whole of the "nucleated-revolving" system in an average (statistical) sense. In fact, there is neither the nucleus nor the peripheral particle at the position center of the "nucleated-revolving" system. Therefore, by detecting the motion of the whole system via the position center (just as what we do at our existence scale to conduct microscopic experiments), we can only attain a statistical result in the end.

Take hydrogen atom as an example. We can detect the wave character of a hydrogen atom in experiment just because we probe the motion of the position center as the proxy of the whole hydrogen atom. For small humans, they do not probe the

position center of a hydrogen atom to describe its motion because in their eyes, a hydrogen atom is as big as a solar system and they can directly determine the position of proton and electron just as we directly probe the position of sun and earth. So what they get is not a statistical result. In a word, that's to say, whether or not obtaining a statistical result is relative. We get the statistical result is some kind of effect of **Scale Relativity**.

De Broglie Relation, Schrödinger Equation and Born Interpretation The concept of matter wave was given by de Broglie in 1924[11]. He was enlightened by the wave-particle duality of photon and guessed that matter particles may also have wave character. His idea was verified by Davisson and Germer in an experiment of electron diffraction in 1927[12]. The proposition of the concept of matter wave by de Broglie is a much-told tale by physicists as a successful example of using analogy. By analogy, de Broglie established the famous relation:

$$\lambda \cdot p = \hbar . \tag{37}$$

Comparing (37) with (32), we will find that de Broglie relation is another expression of uncertainty relation actually. In other words, they are the same thing in essence. They are all results of the conservation of angular momentum and energy of the "nucleated-revolving" system.

Schrödinger equation was established by Schrödinger in 1926[13]. It is also a result of analogy. Schrödinger analogized the moving free particle with the propagation of plane wave and established the wave equation named by his name. The concept of wave function originates from his work. While seen in the direct meaning, the wave in

Schrödinger's equation and the wave in de Broglie's relation are not the same "wave". For example, the wave length in de Broglie relation has a dimension of length and a direct physical meaning. While the wave length for the wave in Schrödinger equation has no direct meaning because it is a wave in complex space. Therefore, the wave in de Broglie relation and the wave in Schrödinger equation are not the same wave seen from a direct meaning. The essence of the wave in Schrödinger equation is an artificial empirical formula reflecting the wave character of the action of a "nucleated-revolving" system.

Born's interpretation for wave function[14] is called the "Copenhagen" orthodox interpretation. However, the wave in Born's interpretation is a wave of probability (amplitude), and seen from its direct meaning, it is neither the same to the wave in de Broglie relation (whose wave length has a dimension of length) nor the same to the wave in Schrödinger equation (which is the wave of action in complex space). The probability in Born interpretation essentially reflects the distance from some point of the space to the position center of the "nucleated-revolving" system. Just because of Born's interpretation, the normalization of wave function comes into practice. In fact, no matter for the wave in Schrödinger equation or for the wave in de Broglie relation, there is no need of normalization. Because de Broglie established his relation by analogy with the light wave, just as there is no need of normalization for the light wave, de Broglie's matter wave also does not need normalization. Similarly, Schrödinger established his equation by analogy with ordinary plane wave (such as mechanical wave or electro-magnetic wave), therefore, Schrödinger's wave does not

need normalization too just as ordinary plane wave does. However, Born proposes the probability interpretation for wave function in a situation that people have no idea about the origin of the matter wave (i.e., no realization of the ubiquity of the "nucleated-revolving" structure of micro particles) but want to give a unified comprehension of wave-particle duality, thus eliciting the problem of normalization of the wave function.

Summarizing the above, we know that seen from the direct meaning, the wave in de Broglie relation and the wave in Schrödinger equation and the wave in Born interpretation have different meaning, respectively. However, they are also reflections from different aspects for the same underlying wave: the wave-like trajectory of the position center of the "nucleated-revolving" structure of micro particles. De Broglie relation reflects the conservation of the angular-momentum (or energy) of the "nucleated-revolving" system; Schrödinger equation reflects the wave character of the action of the "nucleated-revolving" system; while the Born interpretation reflects the distance from some point of the space to the position center of the "nucleated-revolving" system.

Wave-Particle Duality From the above deduction, we know that the motion of a "nucleated-revolving" system spontaneously demonstrates the wave character (of the position center) as a whole (the essence of wave is just the propagation of periodicity). On the other hand, the object who can spontaneously demonstrates the wave character must be a "nucleated-revolving" system. Electrons show some stationary-wave-like character on the orbits around the nucleus of an atom; therefore they must have

"nucleated-revolving" structures. Generally speaking, any micro particles (except bosons, see explanation later) are "nucleated-revolving" systems.

Now make a comparison with solar system. Earth is running around the sun and the moon is running around the earth. The mass ratio between earth and moon is 80:1, and then the position center of earth-moon system and the mass center of this system do not superpose with each other, and then the trajectory of the position center of the earth-moon system must be a standing wave surrounding at the orbit of the mass center of this system (Figure 9). In addition, our solar system is composed of about ten planets, from which it can be speculated that the sun may be also not a unitary solid ball and that it may be a composite ball made up of about teen ~ twenty small balls as parts of it seeming like an atom nucleus. If really so, some characters of the composite ball may demonstrate in the activities of the sun, for example, the sunspots may be the seams between these part balls, and the precession of perihelion of the planets may originates from the non-uniformity of the gravitation due to the non-uniformity of the density of sun as a composite ball.
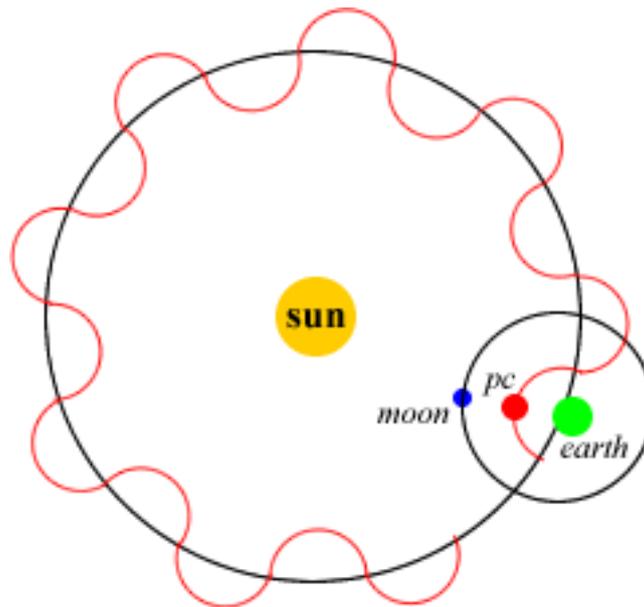
Figure 9. Illustration for the trajectory of the position center of earth-moon system.

The essence of matter wave is the wave-like motion of the position center of a "nucleated-revolving" system which embodies the wave-particle duality very well: On one hand, position center demonstrates spontaneously the wave character in the moving; on the other hand, at a specific time, the position center has a specific position so that it also demonstrates the particle character as a whole. However, as aforementioned, position center is just position center; it only represents the position of the whole system in an average (statistical) sense. Therefore, the whole particle only has certain position in a statistical meaning and the results of our experiments remains statistical.

After knowing the essence of matter wave, we can then evaluate different sorts of interpretations for wave function. The following is the evaluation of two representative standpoints. One is Schrödinger's wave package interpretation which emphasizes the wave character too much to face the problem of diffusion of wave package. In fact, from the wave-like motion of the position center, we know that the

"nucleated-revolving" system does not diffuse because the attractive inner force between the two parts (nucleus and the peripheral particle). The other interpretation is the ensemble interpretation from Einstein which thinks that the wave character is a collective property of a large quantity of particles which originates from their aggregation. This interpretation emphasizes the particle character too much. In fact, as what we know now, the essence of matter wave is a kind of composite motion (the compound of revolution and translation), and an intrinsic property of "nucleated-revolving" system which can be demonstrated by a single particle and does not rely on the aggregation of many particles. Therefore, the above two interpretations for wave function are all biased in meaning and lose the key point of the truth.

Just as what is said above, because of the **relativity of measure**, whether the wave character is significant or not is also relative. For small human, electrons seem as big as planets, and thus they do not care the wave character of electrons. Likewise, for big human, our earth is as small as an electron, and our solar system is not more than an atom. Therefore, if big humans make a big grating and take a beam of solar systems to throw on it, they will also detect the diffraction phenomenon of solar systems. Hereby, we know that the wave character and particle character are relative, and they are only some kind of effect of **Scale Relativity**.

Scale Transformation, Symmetry Breaking, Randomness and the Time Arrow

With the above discussion about matter wave, we can now discuss "Scale Transformation" in more details. "Scale transformation" is actually a simple averaging (summarizing) procedure. Because summarizing operation is a

many-to-one map, it is an irreversible procedure which is the origin of symmetry breaking and randomness. The reason is simple: we know $1 + 1 = 2$, but if it is asked that 2 equals what? The answer is not necessarily to be $1 + 1$, because $1.5 + 0.5$ or $0.8+1.2$ also equals to 2. That is to say, if knowing the two addends, we can uniquely determine the sum while if knowing the sum, we cannot uniquely determine the two addends. The essence of matter wave may serve as an excellent example to explain that the randomness just originates from "Scale Transformation".

According to "Statistical principle" (special coexistence principle), we know that there are two scales for the description of the state of matter motion: microscopic and macroscopic. At microscopic scale, we can directly describe the motion of the two parts of the "nucleated-revolving" system and need not describe the whole of the system in a manner of position center approximation, therefore uncertainty does not appear. While if because of the limitation of scale, we have to describe the whole of the "nucleated-revolving" system in a manner of position center approximation, then we have to perform a statistical averaging to get the position center of the whole system (usually, this is automatically done by our apparatus which is used for measurement and so we need not do it explicitly) which is an irreversible single direction physical procedure because knowing the positions of the two parts of the "nucleated-revolving" system we can uniquely determine its position center while knowing the position center of the system, we cannot uniquely determine the positions of the two parts, which is the origin of randomness.

The concept of **Time Arrow** is extensively discussed in recently years such as by

Stephen Hawking in his "A Brief History of Time"[6] or by Ilya Prigogine in his "The End of Certainty"[15]. The time arrow is just a simple fact: every one of us (except some patients suffering mind diseases) can feel the single direction of time as it is always going from yesterday to today to tomorrow. But why the time is single directional? This problem is not a simple one. To know the answer of this question, we have to refer to the reversibility of physical process. Yet the reversibility of a physical process relies on the determinacy of the physical law that dominates the process. If the physical law is of certainty, just like Newton laws, then the physical process is reversible in principle. Owing to the great success of Newton's mechanics, there prevailed a kind of mechanical world view in eighteen century which believes that the universe is some kind of huge clock. It was said that Laplace had thought that if the position and momentum of each particle are given at a specific time, he can (at least in principle) work out the past and the future of the universe and then time is meaningless in his eyes. Later, due to the appearance and the developments of thermodynamics, it seems to have found the explanation for the time arrow: that is the second law of thermodynamics, i.e. the principle of entropy increase (in an isolated system). If we take the universe as an isolated system (it sounds reasonable because the universe is defined as the totality of our world; then according to this definition, there is nothing outside the universe and if there is, it should be included in the definition), then the single direction of entropy increase may be the underlying reason of the single direction of time. However, this is only a simple correspondence (map); it gives neither the mechanism of time arrow nor the reason why entropy increases.

Here, we shall tell that the increase of entropy and the arrow of time just come from "Scale Transformation". It is generally acknowledged that entropy is a measure of the microstate number of a system and the application of entropy increase principle relies on the adequate randomness of the system, i.e., ergodicity must be satisfied. As aforementioned, randomness just originates from the "Scale Transformation" and this is the precondition of the application of entropy increase principle and the entropy increase principle is only useful for a description of microstates at a macroscopic level. If we can directly measure and control the system at microscopic level (as if we have the ability of Maxwell's demon), then entropy is a useless concept for us (Note: if we do not care a more microscopic existence scale) and every process is reversible for us and thus there is no single directional time in our eyes.

Summarizing the above, we know that there is no absolute reversibility or irreversibility for a physical process and that there is no absolute certainty or randomness of physical phenomenon. Whether a physical process reversible or not and whether a physical phenomenon certain or random rely on the measure scale. We detect the motion of an electron to be random but for small human, the motion of an electron is completely certain no matter for position or momentum. So whether or not time is reversible are relative and the time arrow is a kind of effect of Scale Relativity.

The Essence of Field

What is Field? Field is meson flow. And the force lines are intuitive description of field.

What is Magnetic Field? Magnetic field is a kind of measure effect of "Motion

Relativity" (Einstein's special relativity) coming from the space contraction.

As shown in Figure 10, suppose the interactions between the protons in A_1 and the protons in A_2 is F_{p1}^{p2} and the interactions between the electrons of A_1 and those of A_2 is F_{e1}^{e2} and the interactions between the protons in A_1 and the electrons in A_2 is F_{p1}^{e2} and the interaction between the electrons in A_1 and the protons in A_2 is F_{e1}^{p2}. Then,

$$F_{attractive} = F_{p1}^{e2} + F_{e1}^{p2}, \qquad F_{repulsive} = F_{p1}^{p2} + F_{e1}^{e2} \tag{38}$$

Electric current in the same direction   Electric current in the opposite direction
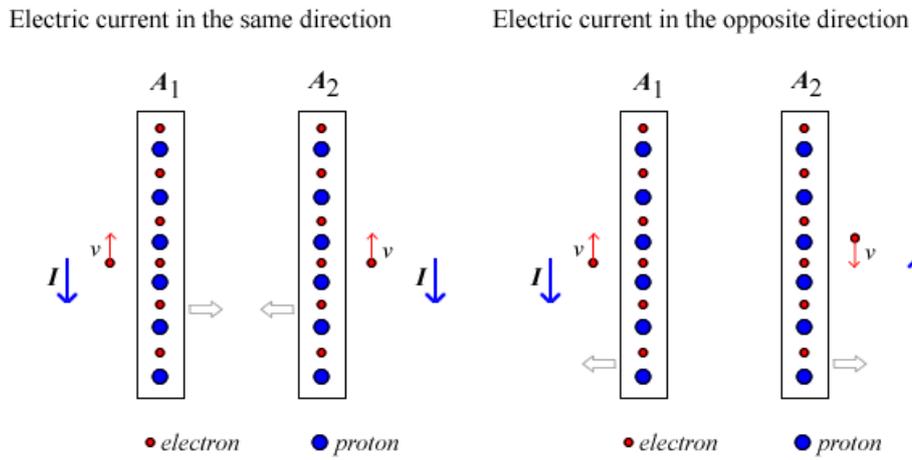

Figure 10. Schematic illustration for the generation of magnetic filed. When the electric currents in the two conductors A_1 and A_2 are in the same direction, the two conductors attract each other and when the electric currents in them are in the opposite direction, they repulse each other.

Before adding voltage, because there are equal positive and negative charges in the two conductors, there is

$$F_{p1}^{p2} = F_{e1}^{e2} = F_{p1}^{e2} = F_{e1}^{p2}, \tag{39}$$

and thus

$$F_{attractive} = F_{repulsive}. \tag{40}$$

After charging, the electrons in the two conductors begin directional movements (without losing generality, suppose the magnitudes of the two currents in the two conductors are equal to each other).

Firstly, we see the situation where the two currents in the two conductors are in the same direction. In this case, the protons in the two conductors are resting relative to each other and the electrons in the two conductors are resting relative to each other too. Therefore, F_{p1}^{p2} and F_{e1}^{e2} do not change, and thus the repulsive force between the conductors $F_{repulsive} = F_{p1}^{p2} + F_{e1}^{e2}$ also does not change, i.e.,

$$F'_{repulsive} = F_{repulsive} = F_{p1}^{p2} + F_{e1}^{e2} \qquad (41)$$

where $F'_{repulsive}$ is the repulsive force after charging.

The electrons in A_2 have a directional speed v relative to the protons in A_1, and then because of the conservation of the quantity of electricity (i.e., the quantity of electricity is an invariant of "motion relativity") and the contraction effect of length (of the "motion relativity"), the areal number density of meson flow emitted from the protons in A_1 and received by the electrons in conductor A_2 seems increased and as a consequence F_{p1}^{e2} increased. The following is a concise deduction procedure.

According to length contraction formula of "motion relativity",

$$L = L_0 \sqrt{1 - \frac{v^2}{c^2}} \cong L_0 \left(1 - \frac{1}{2}\frac{v^2}{c^2}\right) = L_0 \left(1 - \frac{1}{2}\beta^2\right) \qquad (42)$$

there is

$$\Delta L = L - L_0 = -\frac{1}{2}\beta^2 L_0 . \qquad (43)$$

Let

$$L \downarrow = \left|\frac{\Delta L}{L_0}\right| = \left|-\frac{1}{2}\beta^2\right| = \frac{1}{2}\beta^2 . \qquad (44)$$

Then "$L \downarrow$" is the decrease factor of length.

According to the definition of the areal number density of meson flow, there is

$$\because D_a = \frac{Q}{A} = \frac{Q}{LL_0} \quad \text{and} \quad L \downarrow = \frac{1}{2}\beta^2$$

$$\therefore D_a \uparrow = \frac{1}{2}\beta^2 \tag{45}$$

where "$D_a \uparrow$" is the increase factor of the areal number density of meson flow.

Therefore,

$$F_{p1}^{e2} \uparrow = \frac{1}{2}\beta^2 \quad \text{and} \quad F_{e1}^{p2} \uparrow = \frac{1}{2}\beta^2 \tag{46}$$

and then

$$F_{attractive} \uparrow = \left(F_{p1}^{e2} + F_{e1}^{p2}\right) \uparrow = \frac{1}{2}\beta^2 . \tag{47}$$

As a result,

$$F'_{attractive} = F_{attractive}(1 + \frac{1}{2}\beta^2) = F_{attractive} + \frac{1}{2}\beta^2 F_{attractive} > F'_{repulsive} \tag{48}$$

where the $F'_{attractive}$ is the attractive force after charging. Then we detect the phenomenon of a net attraction between the two conductors which looks like there is magnetic field between the two conductors.

Secondly, we see the situation where the two currents in the two conductors are in the opposite direction. In this case, the protons in the two conductors are resting relative to each other and then, F_{p1}^{p2} does not change. The relative speeds of electrons in the two conductors are $2v$ (Here Galileo velocity addition law is used because the speeds of the directional motion of electrons in conductors are not very high), then the length contraction factor is

$$L \downarrow = \left|\frac{\Delta L}{L_0}\right| = \left|-\frac{1}{2}\left(\frac{2v}{c}\right)^2\right| = 2\beta^2 \tag{49}$$

Then, there is $F_{e1}^{e2} \uparrow = 2\beta^2$.

Therefore,

$$F'_{repulsive} = F_{p1}^{p2} + F_{e1}^{e2} = F_{p1}^{p2} + \left(1 + 2\beta^2\right)F_{e1}^{e2} = F_{repulsive} + 2\beta^2 F_{e1}^{e2} = F_{repulsive} + \beta^2 F_{repulsive} \cdot$$

Consider

$$F'_{attractive} = F_{p1}^{e2}\left(1 + \frac{1}{2}\beta^2\right) + F_{e1}^{p2}\left(1 + \frac{1}{2}\beta^2\right) = F_{attractive} + \frac{1}{2}\beta^2 F_{attractive}$$

and

$$F_{attractive} = F_{repulsive} \text{,}$$

we arrive at

$$F'_{repulsive} > F'_{attractive} \tag{50}$$

Then we shall detect a net repulsion between the two conductors which are explained as the magnetic field between the two conductors.

From the above, we know that the magnetic field is a kind of effect of "motion relativity" (special relativity) of electric field, namely, the motion of electricity generates the magnetism. There is never magnetism without electricity. So, magnetic charge and magnetic monopole do not exist.

What is Gravitation? Gravitation is the most common force around us. According to Einstein's General Relativity, it can be regarded as the curvature of space-time[16, 17]. In 2005, Prof. R. C. Gupta (I.E.T., Lucknow, India) has proposed an alternative explanation that gravity can be regarded as the second-order relativistic manifestation of electrostatic force[18]. The following figure and table are recreated according to Prof. Gupta's ideas.
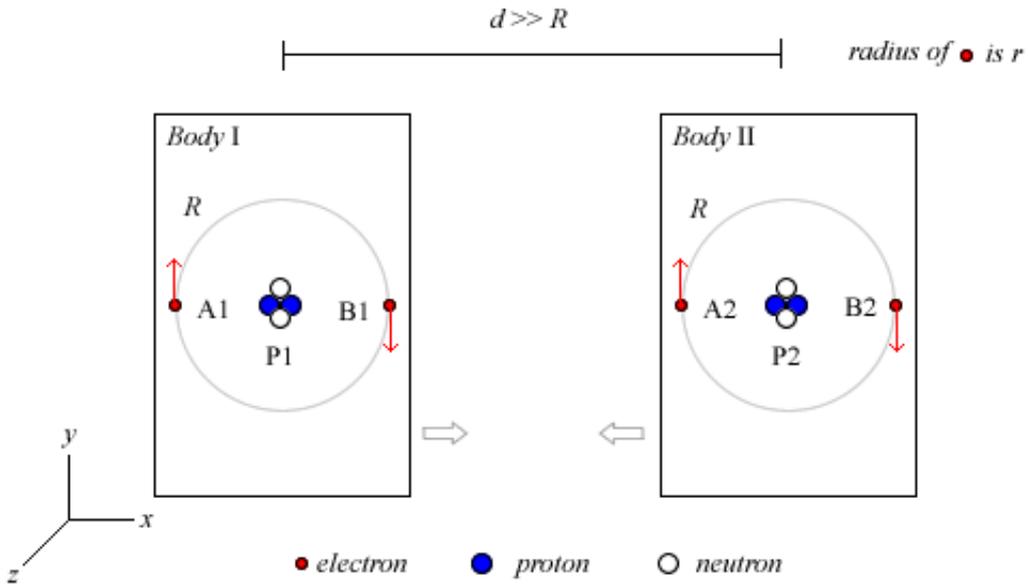
Gravitation between two bodies

Figure 11. Schematic illustrations for the generation of gravitational field. Suppose two bodies (body I and body II) contain Helium-like atoms; the distance d between the two bodies is far larger than the radius of the atoms R. For simplicity, suppose two atoms (each one in each body) are arranged as shown where A1 & B1 are electrons in Body I and A2 & B2 are electrons in body II; the two protons in body I are grouped as P1 and the two protons in body II are grouped as P2. The net Attraction (+) and Repulsion (-) factors between electrons and protons of the two atoms in the two bodies due to length contraction are listed in the following Table.

Table 1 Net Attraction (+) and Repulsion (-) factors between electrons and protons of the two atoms in the two bodies due to length contraction

Observations	Net Attraction (+) or repulsion factor due to length contraction	
	Without relativistic velocity addition (first order effect)	**With relativistic Velocity addition (second order effect)**
A1 as observer sees A2	$0 \qquad = 0$	$0 \qquad\qquad = 0$
A1 as observer sees P2	$+2 \text{x} (1/2) v^2/c^2 = +\beta^2$	$+2 \text{x} (1/2) v^2/c^2 = +\beta^2$
A1 as observer sees B2	$(-1/2)\text{x}(2v)^2/c^2 = -2\beta^2$	$(-1/2)\text{x}(2v)^2/c^2\{1/(1+v^2/c^2)^2\}=-2\beta^2(1-2\beta^2)$
B1 as observer sees A2	$(-1/2)\text{x}(2v)^2/c^2 = -2\beta^2$	$(-1/2)\text{x}(2v)^2/c^2\{1/(1+v^2/c^2)^2\}=-2\beta^2(1-2\beta^2)$
B1 as observer sees P2	$+2 \text{x} (1/2) v^2/c^2 = +\beta^2$	$+2 \text{x} (1/2) v^2/c^2 \qquad = +\beta^2$
B1 as observer sees B2	$0 \qquad = 0$	$0 \qquad\qquad = 0$
P1 as observer sees A2	$+2 \text{x} (1/2) v^2/c^2 = +\beta^2$	$+2 \text{x} (1/2) v^2/c^2 \qquad = +\beta^2$
P1 as observer sees P2	$0 \qquad =0$	$0 \qquad\qquad = 0$
P1 as observer sees B2	$+2 \text{x} (1/2) v^2/c^2 = +\beta^2$	$+2 \text{x} (1/2) v^2/c^2 \qquad = +\beta^2$
atom-I as observer sees atom-II	**Total** $\qquad = 0$	**Total** $\qquad \approx + 8\beta^4$

As shown in Figure 11 and Table 1, the net attraction will appear when the Lorentz velocity addition law is used in the length contraction formula and Newton's gravitational formula can be derived from Coulomb's electrostatic force formula to be:

$$
\begin{aligned}
F &= \{1/(4\pi\varepsilon)\}\cdot q_1\left[q_2 f\right]/d^2 \\
&= \{1/(4\pi\varepsilon)\}\left(\tfrac{1}{2}N_A m_1 e\right)\left[\tfrac{1}{2}N_A m_2 e\cdot\{K(v/c)^{n_1}(r/R)^{n_2}\}\right]/d^2 \qquad (51) \\
&= G\cdot m_1 m_2/d^2
\end{aligned}
$$

and the gravitational-constant G can be theoretically estimated as:

$$
G = \{(\tfrac{1}{2}N_A e)^2/(4\pi\varepsilon)\}\cdot\{K(v/c)^{n_1}(r/R)^{n_2}\}. \qquad (52)
$$

The detailed procedure for the deduction and estimation of these formulas are presented in Gupta's paper[18].

According to Prof. Gupta, the "Van der Waals" force between two mesoscopic bodies such as two molecules, which are due to charge distribution, can be regarded as the "zeroth-order" relativistic effect of electrostatic force, meaning with "no" relativistic effect at all; the magnetism can be regarded as "first-order" relativistic manifestation of electrostatic force because it considers the length contraction of special relativity; and the interactions between two macroscopic bodies can be regarded as the "second-order" relativistic manifestation of electrostatic force of special relativity because it considers the relativistic velocity addition (Lorentz velocity addition law). This view can conceptually unify the (long range) interactions as electrostatic force and its relativistic effects. But there are residual problem of this view because the gravitation between two neutrons cannot be explained in the way of two atoms unless that neutrons can also be regarded as a nucleated structure like

atoms. According to special super general relativity, we know that all the (real) particles have a "nucleated-revolving" structure. Then the forces can be unified as the inverse-square interaction and its relativistic effects, which fulfills the unification of long range interactions.

Does the mass really increase? The mass of a body will increase with the increase of the body's speed is an important inference of special relativity (motion relativity). But is this the truth? Up to now, our evidence about the increase of mass mainly comes from the acceleration experiments where it is found that it becomes more and more difficult to accelerate particles and when it is calculated using the formula of charge-mass ratio and seems as if the mass has increased. However, what about the truth? This should be started from the mechanism of acceleration. When a particle is accelerated in the external field, the increase of its momentum comes from the impulsive force of meson flow. Figuratively, it seems like a cobble is pushed rolling by the flow of a brook. The rolling speed of the cobble cannot surpass the speed of the stream. And when the speed of the cobble becomes faster and faster, the difference between the speeds of the cobble and the stream becomes smaller and smaller, and then the impulsive force the cobble received becomes less and less, and as a result, it seems that the cobble becomes more and more difficult to be accelerated. If we take the impulsive force as an invariant, we will think that the mass of the cobble is increased. While in fact, the mass of the cobble does not change, and just the impulsive force becomes less and less. Similar situation appears for particles to be accelerated. Therefore, we know that mass just like electricity is also an invariant of

"motion relativity". Previously, thinking the increase of the mass with the speed is a misunderstanding.

Electricity and Mass Essentially, mass and electricity are the same physical quantity: inverse-square quantity. They are the same physical quantity manifested at different existence scales. If the matter is not infinitely divisible, then if electricity is discrete, mass is discrete. In fact, as aforementioned, the matter is infinitely divisible, so discreteness and continuity is relative, just a kind of effect of **Scale Relativity**. The discreteness of charge originates from our observation scale and the inadequate resolution of our apparatus. In fact, fractional charge has been suggested in QCD. This has already challenged the traditional view of integral discreteness of electricity. It can be reasonably expected that the relativity of discreteness and continuity will be recognized with the development of the resolution of our apparatus.

What is Spin? Spin is the self-rotation of a particle and at the same time, is the revolution of the peripheral particle on its orbit around the nucleus. Therefore, the angular momentum of spin and the angular momentum of orbit of peripheral particle are relative and up to our observation scale. What is spin (the angular momentum of self-rotation) seen from the macroscopic scale where the nucleated structure of the particle is out of sight may be the angular momentum of orbit of the peripheral particle when seen from microscopic scale where the nucleated structure of the particle is in sight; and vice versa. This is why they keep to the same commutation relation. Spin, as a kind of angular momentum, reflects the polarity of a particle or more accurately speaking, the directional property of a particle. Why we always get

two values of spin (a positive one and a negative one) when we detect the spin of fermions? The reason is as follows. Although, as angular momentum, the spin of a particle can have many directions, but when coupling with each other as magnetic moment, there are only two arrangement states of equilibrium: up-magnetic (paramagnetic) and down-magnetic (diamagnetic). The former is a stable equilibrium and has lower energy; and the latter is an unstable equilibrium and has higher energy. That is why we can only detect two values of spin.

What is isospin? It is a wrong concept introduced in a wrong way. It has its historical meaning in a phenomenological theory staying in an empirical stage, but it cannot be taken as a concept with the meaning of truth. Once we have recognized the true structure of matter, we should abandon it in time.

Does light "really" exist?

This is an advanced topic. According to the first chapter of bible, the first thing that the creator created is the light. God said: "Let there be light", and there was light. But does light really exist? We'll begin the topic from the difference between fermions and bosons.

Fermions and Bosons In quantum mechanics, the particles with half spin are called fermions and the particles with integer spin are called bosons because they keep to different statistical laws: bosons keep to Boson-Einstein statistics and fermions keep to Fermi-Dirac statistics. An import difference between bosons and fermions is whether they keep to Pauli's exclusion principle. This difference is an essential one which differentiates the "real" and "virtual" of a particle. Fermions are

real particles because only real particles occupy the space and have an exclusive property but virtual particles have not. Therefore, standing on a point of substantialism, bosons do not exist. Bosons are always emitted from one fermion and absorbed by another fermion and serve as the media between two fermions. Bosons reflect the relationship between two fermions and have no position in substantialism. Figuratively, if the two fermions interacting with each other can be analogized as man and women, the bosons can be analogized as the love between them. Love is virtual and has no position in substantialism. It does not occupy our 3D space and merely reflect the relationship between two persons.

Therefore, we say that bosons as the media particles are not real particles. They have no position in substantialism and do not occupy the volume of 3D space. In this sense, light does not exist because photons are bosons. All the fermions are "nucleated-revolving" system while bosons are not. However, if so, why light also has a wave character? As mentioned above, the wave character is a reflection of "nucleated-revolving" structure. If photons are bosons without a "nucleated-revolving" structure, why do they also wave as the fermions do such as in a diffraction experiment?

Why light waves? The reason is as follows. Photons as a kind of meson reflect the relationship between fermions. No matter in double slits interference experiments or in single slit diffraction experiments, appearing of the bright and dark intervals is a result of the interaction between the fermions on the slits and the fermions on the screen (of course, it also includes the fermions in the light source and in our eyes if

we observe). Therefore, the wave character of light (as shown in the above-mentioned experiments) is not the wave character of photons essentially speaking, but reflects the wave character of the fermions in the slits and on the screen. The wave character of light is only a kind of phenomenological appearance not the essence. It is only a convenient way for understanding and not the truth. On the other hand, light as the mesons between fermions, can propagate of the wave character of one fermion to another leading to interference between fermions. Likewise, electromagnetic wave, as an equivalence of light, its wave character is also a reflection of the wave character of fermions that interact with each other.

The Essence of Light Usually, we cannot recognize the truth of some things just because we and they exist in the same level. To recognize the truth of light, we need outgo the world we are living in to the simulator (running in our super world) which our world is running on to play a role of "God". In fact, super general relativity theory has given us the viewpoint of it. Our world is running on a simulator that works like a cellular automaton and the light is the neighbor-oriented updating rules made by the creator i.e., the rules on how to update the state of the current cell according to the states of its neighbors.

Why the light speed is the maximum and does not change? After having known the truth of the light, we can now explain why the light speed does not change. Because the simulator which our world is running on, as a computational system, needs time to execute instructions, and to judge the states of the neighbors of the present cell to make an update of the state of the present cell needs a fixed number of

clocks; and at the same time, the distance between the present cell and the neighbors whose states can affect the state of the present cell is preset to a fixed number. Therefore, the quotient of the former divided by the latter is also fixed and that is the light speed. Therefore, the light speed does not change. On the other hand, because all the things in the conformation space are made up of cells and their motions are driven by the neighbor-oriented updating rules. So the light speed is also the maximum. Because the essence of light is only the updating rules and does not occupy the conformation space, how does it exist? This should consult the following "Super-Symmetry".

Super-Symmetry Super-symmetry is a great concept. It is proposed originally for the unification of the so-called fundamental interactions. It aims to construct a bigger group to accommodate both bosons and fermions, i.e., letting them be the representation of this group. Regarding particles as representations of groups is a beautiful idea and a model of symmetry guiding physical research. But symmetry is a sward with two sharp edges: It can guide physical research in the right way and also can misguide it. Which result appears depends on whether it is used correctly. If someone wants to find a group to accommodate all the chemical molecules, i.e., rendering them to be the representations of this group, his doing is reasonable or unreasonable just as we render the so-called elementary particles to be the representations of some group. Anyhow, the doing of correlating the group representation with the law of fundamental interaction is unreasonable. The law of fundamental interaction is determined by the dimension of space and has nothing to

do with group representation. But super-symmetry is indeed a great concept if we can realize its essence.

The essence of super-symmetry is the symmetry between the code and data of a program. No matter the code or the data of a program occupies the storage space of the computational system. Seen from this point, they are equivalent and show some symmetry relation. Because our world is running on a simulator built up according to the principles of cellular automaton, super-symmetry here means the symmetry between the rules and the conformations and it is essential for creating a self-existence evolution system.

Super-symmetry is weird but profound. The weirdness of super-symmetry is not less than that of adding two quantities with the different physical dimensions while the profoundness of it can be rated as a revolution of physical thoughts. Super-symmetry dose not only exist in the field of particles, but also plays important roles in the field of life. It is the fundamental elements for the existence and reproduction of living beings. As we know, genetic materials are DNA which is in a structure of double helix in our cell. DNA strands contain at least two aspects of information: the information for the living being's body's construction and the information for its function. Early before Watson and Crick found the double helix structure of DNA, Van Neumann had posed an idea in his self-reproduction machines according to logical analysis that the genetic materials of life should contain two respects of information about body's construction and function, which is the beginning of the idea of super-symmetry. We shall discuss it in more detail in the third

part of this article: Artificial Universe.

String and Roton Representing particles as the different vibration model of strings is a beautiful idea in string theories[19] and can be appreciated as a piece of artwork but cannot be regarded as the truth because there is no solid foundation of this idea. In contrast, "nucleated-revolving" system (called "Roton" for short) is a model with solid foundation that at least the structures of atom and solar system are all this kind of structures. The idea that all the real particles (namely fermions) are Rotons satisfies the invariance of scale transformation and can unify interactions. Logically speaking, there are no more than two forms of interaction: "direct contact" or "via media". In 3D space, the sole reasonable interaction in the form of "via media" (long range interaction) is the inverse-square interaction whose formula has been proved above to be determined by the dimension of the space, and Rotons are the nucleated revolving structures naturally formed under such an interaction. While all the interactions in the form of "direct contact" can be regarded as the combination and decomposition of Rotons.

Roton and Mass Point Roton, as a concept, represents the ubiquitous "nucleated-revolving" structure of particles. It differs from Newton's mass point model in that the mass point model is only a geometric point without inner structures and only with a man-set property: mass, while Roton has a recursive, infinitely divisible "nucleated-revolving" structure. Mass point can be regarded as a far distance approximation of Roton because when observed from a far distance, plenty of inner structures of Rotons are unobservable to the observer due to the distance. But when observed from a near

distance, the details of the Roton structure are not neglectable. The Roton model has some advantages compared with mass point model because it avoids many singularities resulting from the zero volume of a geometric point representation but still can be taken as a point when the cared scale are far larger than the scale of the diameter of the Roton.

(Sep. 30, 2005)

III. Artificial Universe

(An upgrade from creature to creator)

According to the record of "Old Testament", The Creator created our world in six days. He created the light, firmament, plants and so on successively. But the Bible does not tell us that where The Creator comes from and also it does not tell us the details of the creation procedure. In this section, we shall give some clues on the details of the creation procedure according to the new picture of nature provided by super general relativity. Here we shall play the rule of "God" to create different sorts of virtual worlds. In fact, everyone can be a "God" and the creation of a world is also not very difficult. What we need is just an automaton and some programming skills. Let's begin our topic from the structure of the simulator which our world is running on.

Micro Scale: Extended Cellular Automaton

Cellular Automaton and Grid Universe For an introductory definition of cellular automaton, see Ref. 20. Here, Cellular Automaton is defined as an eight-element set,

$$CA = \{S, P, Q, C, I, D, N, U\},\qquad(53)$$

where S is a space, P is some kind of partition of the space S, S and P are called Cellular Space; each part of S (element of P) is called a cell; Q is the set of cellular state; C is the boundary condition of cellular space; I is the initial configuration of the cellular space; D is the configuration, *viz.*, the distribution of cellular states at a step n; N is the neighbor rules and U is the update rules.

The Extension of Cellular Automaton To create a lifelike world, we extend the above ordinary cellular automaton in three aspects: Super-Symmetric, Position Weighted and Multi-Leveled & Bidirectional Causality (Figure 12). Therefore an extended cellular automaton is defined as a nine-element set,

$$ECA = \left\{ S, P, Q, C, I, D_l, N_p, U, R(D, U) \right\} \tag{54}$$

where D_l is the configuration of the grid universe observed at level l and N_p is the position weighted neighbor rules and $R(D, U)$ is a relation (super-symmetry relation) between the configuration D and update rules U.

Extended Cellular Automaton
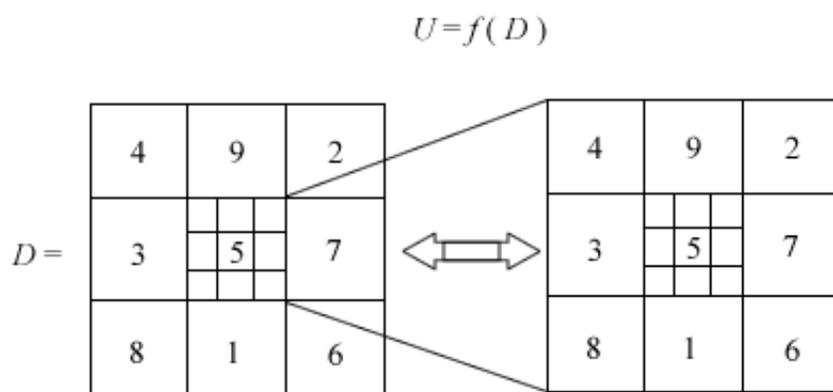
(a) super-symmetric; (b) position-weighted; (c) multi-leveled and bicausality.

Figure 12. Schematic representation of Extended Cellular Automaton.

(a) Super-Symmetric: the symmetry between states and rules. In a super space, the states and rules can be unified, i.e., they can exist in the same existence level so as to interact with each other.

(b) Position-Weighted: different positions are endued with different weights to weight the ability of the neighbors to affect the current cell, which can increase/decrease the symmetry degree of the system such as to make a square configuration have the symmetry degree of a circular one, or vice versa.

(c) Multi-Leveled & Bidirectional Causality: self-similarity of the cellular space manifested in multi-levels. Bidirectional Causality is different from the reductionism in that not only the underlying microstates can determine the apparent macrostates but also the apparent macrostates can inversely act on the underlying microstates. Bicausality makes macrostates change from a pure passive model to an active one.

Light Speed and Special Relativity In the cellular automaton game, for a finite body, if it moves one cell per iteration step, then the object have the maximum speed. It has been proved that nothing can move faster than such a speed in cellular space. Therefore, this speed is called light speed, the being maximum and invariant property of which is the foundation of special relativity[16].

Macro Scale: Simulation Dynamics

In accordance with the recursive simulation structure of super universe, simulation dynamics is the simulation of physical phenomena in an iteration way, which is the kinetics of artificial universe. In simulation dynamics, evolution of a system is an

iteration process and structure of a system is a resultant attractor of iteration process.

Interaction and Transformation

Now consider the "interaction" between body A in world R and body C' in world V. As what we know by far, the sole correlation between them is super transformation, that's, if there exists "interaction" between them, it must be represented by some kind of transformation. In fact, the effect of interaction is leading to motion or changing motion state of a particle/object, which can be fulfilled by a transformation as what to be done in computer graphics[21]. Therefore, an "interaction" is equivalent to a "transformation".

Origin of Inertia

"Interaction", in Aristotle's age, is known as "force", which is regarded as the "cause" of motion. Galileo may firstly notice the inertia of object[22] and Descartes point out that motion of an object needn't a constant "push force"[23]. Subsequently, the great physicist Isaac Newton gives his three laws of motion, and in his first law, he makes it clear that "force" is not the "cause" of motion but the "cause" of changing an object's motion state[24]. Say, if there is no such a "cause", an object will preserve the motion state owing to its inertia.

As to the origin of inertia, it's still an enigma. Via his famous pail experiment, Newton wants to prove the absolute acceleration of water[25] (Later, the centrifugal force in his experiment is taken as "inertia force"). But, Mach disagrees with Newton and thinks that the inertia of an object is a result of the interactions from the other objects in the universe with it[26]. Now we give a new explanation for the origin of

inertia that it originates from the running of **The Simulator** as an automaton, i.e., the automatic property of The Simulator is the origin of inertia.

Simulation Representation

Now consider the simulation of a physical world. The first question we meet is how to represent particles in the simulated world. A natural idea is to represent a particle by a point in that space. But if so, we have nowhere to place physical properties of the particle, because a point has only one property, namely, its position in the simulated space. Of course, we can assign some physical property artificially at programming time, i.e., we define a variable to assign a physical quantity to it and then correlate this variable to the point. But this doing will result in another defect, singularity, such as in Newtonian **mass point** model. In Newtonian mass point model, because the "volume" of a point is zero, any finite mass assigned to it will lead to infinite density, i.e., singularity.

Considering the above defects, we represent a particle by a point set in the simulated space. Point set representation of particles/objects unified the nuclei and field pictures. A particle is represented by a point set and the filed is represented by a partial point flow under a transformation. And the motion of a particle/object is represented by the whole point set flow under another transformation. The partial transformation makes a fast (high speed) flow of some points of the point set and the whole transformation makes a slow (low speed) flow of the whole point set.

Each point in the point set, if observed at a smaller scale, will be a point set. That is, there is self-similarity of the point set. The two kinds of charges are represented by

two directions of point flow: centrifugal and centripetal. Referring to fractal geometrics, a particle can be represented by a Burel set[27] in the simulated space, and thus, an object as a collection of particles can be represented by a union of particle sets. Thus, the physical property can be represented by some kind of "measure" on it. Through different measure definitions, different kinds of physical quantities are simulated.

Motion of a particle/object is represented by a transformation on it just as what to be done in computer graphics[21]. Correlation between particles/objects is represented by the Hausdorff distance between them defined on a fractal space $(F(S), h(d))$ which is defined on the simulated distance space (S, d). In simulation dynamics, the time dimension has been occupied by the running of the simulator, thus, only space is explicit variables in the kinetic equations and time is implicit appearing as subscript.

Iteration Formulism

One particle/object. Suppose a particle/object is represented by a point set P (Burel set) in a simulated space S, then the motion equation of it is:

$$P_{n+1} = \hat{T}(\mu(P, q)) \cdot P_n, \quad n = 0, 1, 2, \cdots, \tag{55}$$

where P_n is the state (i.e. the position in S) of particle/object P in step n of the iteration process and P_{n+1} is the state of P in step $n+1$; $\hat{T}$ is a transformation on P_n which is a function with respect to variable $\mu(P, q)$ which is the Hausdorff q-dimensional measure of point set P; "·" represents the operation of transformation $\hat{T}$ on point set P. The motion of a particle is illustrated in Figure 13. a).

Two particles/objects. Suppose two particles/objects are represented by point set A and B (Burel sets) in the simulated space S, respectively, then the kinetic equation

for them is:

$$\left(A \bigcup B \right)_{n+1} = \hat{T}(\mu(A,q), \mu(B,q), h(A,B)) \cdot (A \bigcup B)_n \quad n = 0,1,2,\cdots, \qquad (56)$$

where $(A \bigcup B)_n$ is the state (positions) of the two particles/objects A and B in step n of the iteration process and $(A \bigcup B)_{n+1}$ is the state of A and B in step $n+1$; $\hat{T}$ is a transformation on $(A \bigcup B)_n$ which is a function with respect to variable $\mu(A,q)$, $\mu(B,q)$ and $h(A,B)$ where $\mu(A,q)$, $\mu(B,q)$ are the Hausdorff q-dimensional measures of point set A and B, and $h(A,B)$ is the Hausdorff distance defined on the fractal space $\left(F(S), h(d) \right)$ where d is a distance defined on the simulated space S; "$\cdot$" represents the operation of transformation $\hat{T}$ on the union of point set A and B. The Hausdorff distance between particle A and B is illustrated in Figure 13. b).

Multiple particles/objects. Suppose these particles/objects are represented by $A_1, \cdots, A_N$, respectively, then the kinetic equation for them is:

$$\left(A_1 \bigcup \cdots \bigcup A_N \right)_{n+1} = \hat{T}(\mu(A_1,q), \cdots, \mu(A_N,q), \underset{k}{h}(A_i, A_j), k = 1, \cdots, C_N^2) \cdot \left(A_1 \bigcup \cdots \bigcup A_N \right)_n,$$

$$(57)$$

where $\left(A_1 \bigcup \cdots \bigcup A_N \right)_n$ is the state (positions) of these particles/objects in step n of the iteration process and $\left(A_1 \bigcup \cdots \bigcup A_N \right)_{n+1}$ is the state of these particles/objects in step $n+1$; $\hat{T}$ is a transformation on $(A_1 \bigcup \cdots \bigcup A_N)_n$ which is a function with respect to variable $\mu(A_1,q)$, $\cdots$, $\mu(A_N,q)$ and $\underset{k}{h}(A_i, B_j)$ where $\mu(A_1,q), \cdots, \mu(A_N,q)$ are the Hausdorff q-dimensional measures of point sets A_1, $\cdots$, A_N, and $\underset{k}{h}(A_i, B_j)$, $k = 1, \cdots, C_N^2$ are the Hausdorff distances between them defined on the fractal space $\left(F(S), h(d) \right)$ where d is a metric defined on the

simulated space S; "$\cdot$" represents the operation of transformation $\hat{T}$ on the union of point sets $A_1, \cdots, A_N$.

For multiple body problems, to avoid the combinatorial explosion of the number of distances for an efficient calculation, we can define a proper "global" measure on the whole system, so that the kinetic equation can be rewritten as:

$$\left(A_1 \bigcup \cdots \bigcup A_N\right)_{n+1} = \hat{T}(\mu_r(A_1 \bigcup, \cdots, A_N, q_r)) \cdot \left(A_1 \bigcup \cdots \bigcup A_N\right)_n, \qquad (58)$$

where $\mu_r(A_1 \bigcup \cdots \bigcup A_N, q_r)$ is the q_r dimensional Hausdorff measure on the whole system $A_1 \bigcup \cdots \bigcup A_N$.

Equations (55), (56), (57) and (58) are the kinetic equations of simulation dynamics for one body, two bodies and multiple bodies, respectively.

Collision: Measure Conservation Law

Particle A occupies some of the space S and particle B too. When they meet with each other, the point sets for them are superposed somewhat. The result is that they are annihilated and the union of them is generated as a new particle, and meanwhile, the intersection of them is released as another new particle (Figure 13. c)). In this process, the total size of point sets is conservational, which lead to the conservation of Hausdorff measure. Because physical quantities are represented by some kinds of Hausdorff measure, they are also conserved in this process. Therefore, the conservation laws of physical world are simulated. When a collection of particles assembles to form a body, the body is the union of the point sets for these particles and the intersection of these point sets is released, some kind of measure on which may be called (as what in our world): the binding energy.
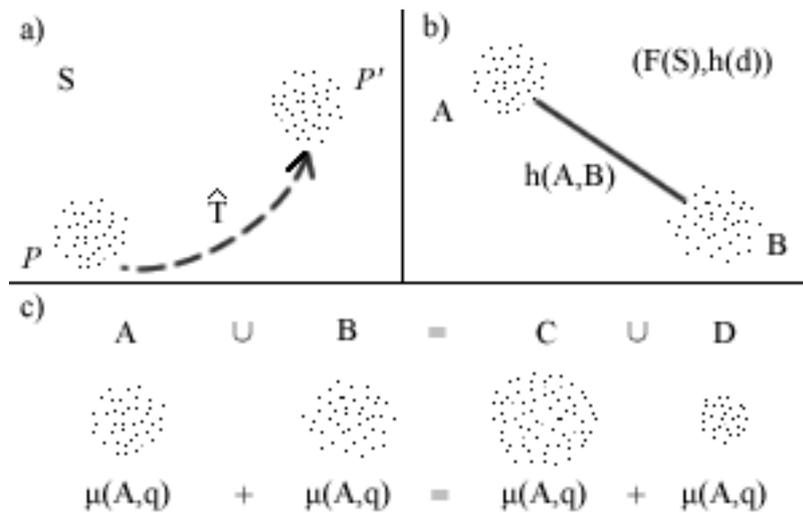
Figure 13. Illustration of simulation dynamics in space *S.* **a)** particle P moves from P to P′ by the transformation T in space S; **b)** the Hausdorff distance h(A,B) between particle A and particle B in fractal space (F(S),h(d)); **c)** particle A collides with particle B, annihilated, and particle C and particle D are generated. Some of the space originally occupied by A and B are released because the superposition of them, and the released part is D, thus there is, D=A∩B. Correspondingly, the Hausdorff q-dimensional measure is conserved in this process.

Three Kinds of Structures

Now we consider system structures in the simulated world. As what we know in our world, there are mainly three kinds of structures: static structure, periodic motion structure and dissipative structure. They can be simulated by the three kinds of attractors of the iterated process (dynamic system), respectively. As shown in Figure 14, the static structure (Figure 14. a)), such as crystals, is simulated by the fixed point attractor; the periodic motion structure (Figure 14. b)), such as atoms, is simulated by the limit circle attractor; the dissipative structure (Figure 14. c)), such as flames, is simulated by the chaotic attractor. Of course, there are some kinds of mixtures of these basic structures, such as a clock (Figure 14. d)) (mixture of static and periodic motion structure), with which people living in the simulated world can tell time just as
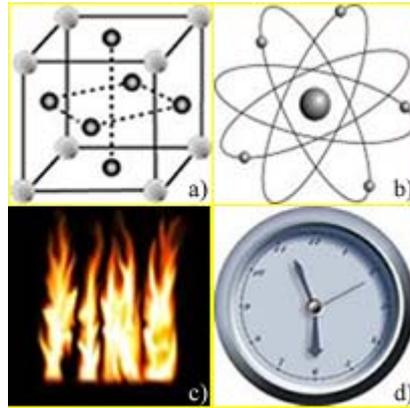
we do in our world: watching a clock.

Figure 14. System structures in simulation Dynamics. a) Static structure, simulated by the fixed point attractor; b) periodic motion structure, simulated by the limit circle attractor; c) dissipative structure, simulated by the chaotic attractor; d) a mixture of static and periodic motion structure which can be used as a timer.

The Levels and Evolution of Artificial Reality

Artificial Universe: Self-existence system, the physical foundation of artificial reality. Artificial universe is a piece of artwork of the super beings of that universe.

Artificial Life: self-producing system, the active agents that can interact with environments. Artificial life is an evolutionary result of artificial universe.

Artificial Intelligence: self-reflection system. Self-reflection is a kind of ability to form a second level reality (mind world) in comparison to the first level reality (material world) where the body of this system lives in. Three points are necessary for a being to be of intelligence: (1) possessing of a first level reality (body world) and a second level reality (mind world); (2) living in the superposed state of the two realities; (3) the ability of doing super transformations, i.e., the ability of jumping between the two worlds. Artificial Intelligence is an evolutionary result of artificial life.

Artificial Society: self-organization system of intelligent active agents. The interdependent relationship of the agents makes it a life-like being. Artificial society is an evolutionary result of artificial universe.

Unification of Science and Religion

1. *Science and Religion* Super General Relativity Theory may uniform Science and Religion. The Creator is the maker of The Simulator. For God-made world where we are living in, we are creatures, while for man-made world where virtual creatures are living in, we are creators. Future may be an age where Creators (gods), Creatures (human beings), and Robots (and virtual creatures) live together.

2. *The Origin of Universe and Life* Three kinds of simulators are mentioned in this paper: The Simulator, Human Brains, and Computers. The Simulator is the simulator where our world is running on, which is a God-made one. Human brains are the evolutionary result of our world and computers are man-made simulators. These three kinds of simulators simulate three kinds of worlds: our world, human imagination, and computer virtual reality. Considering all these three kinds of worlds and the creatures living in them, we know that the origin of the universe and life is neither a simple Creation, nor a simple Evolution, but some kind of mixture of them. Therefore, Super General Relativity unifies the Creation and Evolution. (The unified theory can be called "Crevolution" theory.)

3. *Unomniscience and Unomnipotence of Creators* Creator is the maker of simulator. Because simulator is automaton, maker of it can create a world by making some simple laws/rules, but he cannot completely know and completely determine the running results of the simulator due to its automation property. But creator has ability to break the laws he made to bring some changes directly to the world that he creates, which his creatures may call miracles. Creator as a super being to his creature has more power when he is in his super position. But if he gets involved in the world he created, he must keep to the game rules he himself made. Therefore, creators and creatures are relative, and they have equal rights as beings.

Discussions and Conclusions

Discussions

1. *Quantization of Reality* Since reality is not absolute but relative, the realities of events are comparable in some degree which leads to the quantization of reality.

2. *Physics and Mathematics* The invention of infinitesimal calculus supports the establishment of classical mechanics, and the development of complex analysis supports the establishment of quantum mechanics. Now the emergence of nonlinear science, especially the fractal geometrics and dynamics system theory, will support the establishment of simulation dynamics. The formulism of classical mechanics is real differential equation, and the formulism of quantum mechanics is complex partial differential equation, while the formulism of simulation dynamics is iteration equation. A remarkable difference of formulism between simulation dynamics and the classical & quantum mechanics is that there is no time variable in its kinetic equations.

3. *Tow Viewpoints: Wherein and Whereout* In the picture of super universe, there are two viewpoints of physics study: "wherein viewpoint" and "whereout viewpoint". The wherein viewpoint is the viewpoint from the **simulated** world, and the whereout viewpoint is the viewpoint from the **simulating** world. In Similarity Mechanics, the two viewpoints are **microscopic** and **macroscopic**; In Motion Relativity, the two viewpoints are **mover-side** and **spectator-side**. The kinetic equations of simulation dynamics is established at the whereout viewpoint. It may degenerate to the form of classical mechanics or quantum mechanics when the viewpoint changing from "whereout" to "wherein". From now on, physics study, especially the fundamental physics study, has an alternative choice of viewpoint to establish physical equations. From the "wherein viewpoint", mechanics is relative, while from the "whereout viewpoint", mechanics is absolute.

4. *Super Physics* Super Physics may be the unification of Physics, Metaphysics, and Philosophy. Super Physics mainly has two branches: Super Cosmology and

Psychophysics. Super cosmology is the development of virtual reality, and intends to give a uniform description of recursive virtual worlds. Psychophysics is a redefinition of parapsychology, and intends to give a uniform description of matter world and mind world.

5. *Paradox and Existence* Paradox doesn't mean nonexistence. Paradox often occurs in a self-reflection situation, such as Russell's set paradox. Paradox only exists when talking from the "wherein" viewpoint, while for a spectator from "whereout" viewpoint, many paradoxes do not exist at all.

6. *Why exist?* Existing is just a simple fact for every one. We have no choice on whether or not, when and where we are born. So most people accept the fact of being existence. But there are some people who love to ask why. These people are usually rationalist and believe logic. Here is an answer for them. Try to answer the following question: does nonexistence exist? If nonexistence exists, it's not nonexistence, say, there is only existence; if nonexistence doesn't exist, and then there is also only existence. So existence is a necessary result of logic.

Conclusions

Reality is relative and doesn't equal to physical law. Universe may have many existence levels. Super universe is a big fractal as virtual world net. Our world may be running on a simulator. Simulation is a methodology for universe modeling. Super transformations bridge the three worlds: objective matter world, human mind world and computer simulation world, which makes it possible to give a uniform description of nature. Our world is a big fractal composed of recursive "nucleated-revolving" structures (Rotons). The form the law of fundamental interaction of our world is determined by the dimension of the space. The sole long range interaction of our world is the inverse-square interaction and short range interactions can be regarded as the combination and decomposition of Rotons at different existence scales. The

creation of artificial universe can be done in the formulism of extended cellular automaton at microscopic level and simulation dynamics at macroscopic level. There are two viewpoints for physics research: "wherein" and "whereout". In super general relativity, two viewpoints are: "simulated" and "simulating"; in special super general relativity, they are: "microscopic" and "macroscopic"; while in special relativity, they are "mover-side" and "spectator-side". The existence of two viewpoints is a reflection of relativity of reality.

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