Evidence of Hidden Variable and its Consequence

Huaiyang Cui
Department of Physics, Beihang University, Beijing, 102206, China
Email: hycui@buaa.edu.cn
(September 22,2023, submitted to viXra)

Abstract: In 3D space, a vector needs three basis vectors. It was found that the Lorentz force uses only two basis vectors, leaving the third basis vector as an undefined variable. It is put forward that the third basis vector and its component is able to serve as the quantum hidden variable. Gravitational force also has the similar hidden variable which is responsible for the quantum gravity effects. As an application of the hidden variable theory, it is found that human lifespan is determined by this quantum gravity, further calculation shows that human average lifespan is about 84 years.

1. An evidence of hidden variable

In 3D space, a vector needs three basis vectors. It was found that the Lorentz force uses only two basis vectors, leaving the third basis vector as an undefined variable.

Considering two charged particles q and q', they move at the velocities $\mathbf{v}$ and $\mathbf{v}'$ respectively, as shown in Fig.1. The electromagnetic force $\mathbf{f}$ acting on the particle q from the particle q' is given by

$$\begin{aligned}\mathbf{f} &= q(\mathbf{E}+\mathbf{v}\times\mathbf{B}) = k_e\frac{qq'}{r^3}\mathbf{r} + k_m\mathbf{v}\times\frac{qq'\mathbf{v}'\times\mathbf{r}}{r^3} \\ &= k_e\frac{qq'}{r^3}\mathbf{r} + k_m\frac{qq'}{r^3}[(\mathbf{v}\cdot\mathbf{r})\mathbf{v}' - (\mathbf{v}\cdot\mathbf{v}')\mathbf{r}] \\ &= [k_e\frac{qq'}{r^3} - k_m\frac{qq'}{r^3}(\mathbf{v}\cdot\mathbf{v}')]\mathbf{r} + k_m\frac{qq'}{r^3}(\mathbf{v}\cdot\mathbf{r})\mathbf{v}'\end{aligned} \quad . \tag{1}$$

where we have used the Coulomb law and the Lorentz law, as well as including the Biot-Savart law. The key point is that this electromagnetic force is only based on two basis vectors: **r** and **v'**, namely

$$\mathbf{f} = C_1\mathbf{r} + C_2\mathbf{v}' \quad . \tag{2}$$

where, C_1 and C_2 are the two coefficients. In mathematics, a force expression needs three basis vectors in an inertial Cartesian coordinate system, is given generally by

$$\mathbf{f} = C_1\mathbf{r} + C_2\mathbf{v}' + C_3\mathbf{\Gamma} \quad . \tag{3}$$

where, $\mathbf{\Gamma}$ is the third basis vector in consideration, C_1 , C_2 and C_3 are the three components on these basis vectors respectively. Therefore, the missing third component C_3 in the electromagnetic force in Eq.(3) plays just the role of a **hidden variable *mathematically***. The third component is a simple uncertain variable in the classical physics.

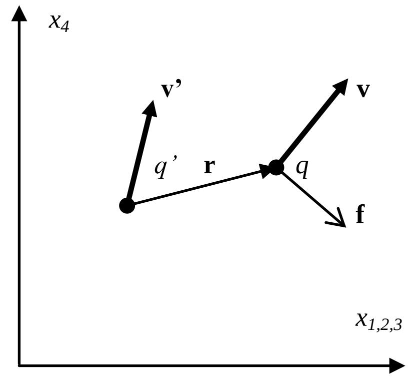

Fig.1 The electromagnetic force **f** between two charged particles *q* and *q'*.

In the history of physics, many attempts were made to look for the quantum hidden variable which accounts for all observed quantum behavior and avoid any indeterminism.

2. Maxwell equations are based on the two basis vectors

In the theory of relativity, the magnitude of the 4-vector velocity *u* keeps on a constant

$$u_1^2 + u_2^2 + u_3^2 + u_4^2 = -c^2; \quad u_\mu u_\mu = -c^2 \tag{4}$$

Any force acting on the particle can never change *u* in the magnitude but change *u* in the direction, the 4-vector force acting on a particle must be orthogonal to the 4-vector velocity of the particle. The orthogonality holds for any kind of force. The electromagnetic force must abide by this orthogonality.

Suppose there are two charged particle *q* and *q'* locating at the positions *x* and *x'* respectively in a Cartesian coordinate system *S*, and moving at the 4-vector velocities *u* and *u'* respectively, *m* denotes the rest mass of the particle *q*. The particle *q* moves in the electric field **E** and magnetic field **B** generated by the particle *q'*. In the 4D space time, the relative position vector *r* is defined under the orthogonal relation: $r \cdot u' = 0$. As shown in Fig.2, the right angles fakely-represents the orthogonality.

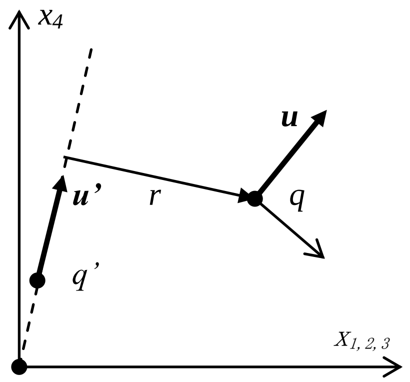

Fig.2 The vector *r* is orthogonal to the velocity *u'*; the force *f* is orthogonal to the velocity *u*.

In order to investigate the 4-vector force concept, we begin with rigorously deriving the electromagnetic force *f* by using two base vectors *r* and *u'*

$$f = Cr + Du' \tag{5}$$

where *C* and *D* are two coefficients in the expansion. Using the orthogonality, we have

$$u \cdot f = C(u \cdot r) + D(u \cdot u') = 0 \tag{6}$$

By eliminating the coefficient *C*, the force becomes

$$f = \frac{D}{(u \cdot r)}[-(u \cdot u')r + (u \cdot r)u'] \tag{7}$$

It follows from the direction of the above expression that the unit vector f^0 of the Coulomb's force is given by

$$f^0 = \frac{1}{c^2 r}[-(u \cdot u')r + (u \cdot r)u'] \tag{8}$$

Suppose that the magnitude of the force *f* has the classical form

$$| f | = \frac{kqq'}{r^2} \tag{9}$$

Combining the above two equations, we obtain a modified Coulomb's force

$$\begin{aligned} f &= | f | f^0 = \frac{kqq'}{c^2 r^3}[-(u \cdot u')r + (u \cdot r)u'] \\ &= q[-(u \cdot \frac{kq'u'}{c^2 r^3})r + (u \cdot \frac{kq'r}{c^2 r^3})u'] \end{aligned} \tag{10}$$

$$f_\mu = q[-(u_\nu \frac{kq'u_\nu'}{c^2 r^3})r_\mu + (u_\nu \frac{kq'r_\nu}{c^2 r^3})u_\mu'] \tag{11}$$

Using the relation

$$\frac{\partial}{\partial x_\mu}\left(\frac{1}{r}\right) = -\frac{r_\mu}{r^3} \tag{12}$$

Substituting it into the force expression , we obtain

$$f_\mu = q\left[u_\nu \frac{\partial}{\partial x_\mu}\left(\frac{kq'u_\nu'}{c^2 r}\right) - u_\nu \frac{\partial}{\partial x_\nu}\left(\frac{kq'u_\mu'}{c^2 r}\right)\right] \tag{13}$$

The force can be rewritten in terms of 4-vector components by

$$f_\mu = qF_{\mu\nu}u_\nu; \quad F_{\mu\nu} = \frac{\partial A_\nu}{\partial x_\mu} - \frac{\partial A_\mu}{\partial x_\nu}; \quad A_\mu = \frac{kq'u_\mu'}{c^2 r} \tag{14}$$

Thus the *A* expresses the 4-vector potential originated from the particle *u'*. It is easy to find that this force is the relativistic 4-vector Lorentz force which contains the usual classical Lorentz force.

From this force, because of the orthogonality $r \cdot u' = 0$, see Fig.2, we have

$$u_\mu ' r_\mu = 0 \tag{15}$$

$$\frac{\partial A_\mu}{\partial x_\mu} = \frac{kq' u_\mu '}{c^2} \frac{\partial}{\partial x_\mu}\left(\frac{1}{r}\right) = \frac{kq' u_\mu '}{c^2}\left(\frac{-r_\mu}{r^3}\right) = 0 \tag{16}$$

This is known as the Lorentz gauge. To note that r has

$$\frac{\partial}{\partial x_\mu}\left[\frac{\partial}{\partial x_\mu}\left(\frac{1}{r}\right)\right] = -4\pi\delta(r) \tag{17}$$

From this force, we have

$$\begin{aligned} \frac{\partial F_{\mu\nu}}{\partial x_\nu} &= \frac{\partial}{\partial x_\nu}\frac{\partial A_\nu}{\partial x_\mu} - \frac{\partial}{\partial x_\nu}\frac{\partial A_\mu}{\partial x_\nu} = -\frac{\partial}{\partial x_\nu}\frac{\partial A_\mu}{\partial x_\nu} \\ &= -\frac{kq' u_\mu '}{c^2}\frac{\partial}{\partial x_\nu}\frac{\partial}{\partial x_\nu}\left(\frac{1}{r}\right) = \frac{kq' u_\mu '}{c^2} 4\pi\delta(r) \end{aligned} \tag{18}$$

We define $J_\mu ' = q' u_\mu ' \delta(r)$ as the density current of the source q', we have

$$\frac{\partial F_{\mu\nu}}{\partial x_\nu} = \mu_0 J_\mu ' \tag{19}$$

From this force, by exchanging the indices and taking the summation of them, we have

$$\frac{\partial F_{\mu\nu}}{\partial x_\lambda} + \frac{\partial F_{\nu\lambda}}{\partial x_\mu} + \frac{\partial F_{\lambda\mu}}{\partial x_\nu} = 0 \tag{20}$$

The above two equations construct up the Maxwell's equations. For continuous media, they are valid as well as, as shown in Fig.3.

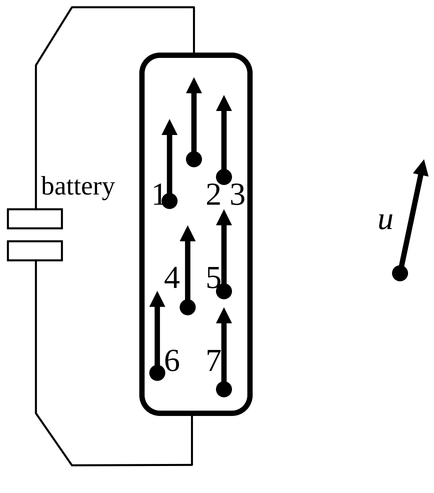

Fig. 3 The vector potential is generated from a circuit, the Maxwell's equations are still valid.

The vector potential from a circuit is given by

$$A_\mu = \sum_i \frac{kq' u_{i\mu}'}{c^2 r_i} \tag{21}$$

The sum takes over all moving particles in the circuit. The Maxwell's equations near the circuit are given by

$$\frac{\partial F_{\mu\nu}}{\partial x_\nu} = \mu_0 J_\mu ' \tag{22}$$

$$\frac{\partial F_{\mu\nu}}{\partial x_\lambda} + \frac{\partial F_{\nu\lambda}}{\partial x_\mu} + \frac{\partial F_{\lambda\mu}}{\partial x_\nu} = 0 \tag{23}$$

The above derivation indicates that the electromagnetic force *f* can be derived from the classical Coulomb's force and its orthogonality for the 4-vector velocity of particle, and the Maxwell's electromagnetic equations can also be derived from the same formalism.

The most important thing is that the electromagnetic 4-vector force has only two independent components, since Eq.(2) has only two base vectors. This is severe problem, implying that there is a missing component that remains in undefined status, because we all know that the 4-vector force should have three independent components.

3. The consequence of the hidden variable to gravitational force

Similar to the Lorentz 4-force, a gravitational force is usually based on two basis vectors: **r** and **v'**, namely

$$\mathbf{f} = C_1 \mathbf{r} + C_2 \mathbf{v}' \ . \tag{24}$$

where, C_1 and C_2 are the two coefficients. In mathematics, a force expression needs three basis vectors in an inertial Cartesian coordinate system, is given generally by

$$\mathbf{f} = C_1 \mathbf{r} + C_2 \mathbf{v}' + C_3 \mathbf{\Gamma} \ . \tag{25}$$

where, $\mathbf{\Gamma}$ is the third basis vector in consideration, C_1 , C_2 and C_3 are the three components on these basis vectors respectively. Therefore, the missing third component C_3 in the above equation plays just the role of a **hidden variable *mathematically***. The third component is a simple uncertain variable in the gravity physics. The gravitational hidden variable actually paves a way to the quantum gravity theory.

This year is the 100th anniversary of the initiative of de Broglie matter wave [3][4]. In recent years, matter wave has been generalized to planetary scale using ultimate acceleration. Consider a particle, its planetary-scale relativistic matter wave is defined by the path integral

$$\psi = \exp\left(\frac{i\beta}{c^3} \int_0^x (u_1 dx_1 + u_2 dx_2 + u_3 dx_3 + u_4 dx_4)\right) \ . \tag{26}$$

where u is the 4-velocity of the particle, β is the ultimate acceleration which is a large constant determined by experiments; the β replaces the *Planck constant* in this quantum gravity theory so that *its wavelength becomes a length on planetary-scale*.

This generalized planetary-scale matter wave can quantize the orbits of solar planets correctly [6]. Based on the clock of the planetary-scale relativistic matter wave, it was found that gravity acting on human blood can provide an oscillation period of up to 100 years which can match well with human lifespan in order of magnitude.

Aging is a complex multifactorial process of molecular and cellular decline that affects tissue function over time. It is unclear, however, how these complex molecular networks are affected by diverse environmental challenges and how they become impaired with aging [1]. Rather than biological time being controlled solely by a molecular cascade domino effect, it is suggested there is also an intracellular oscillatory clock; this clock (life's timekeeper) is synchronized across all cells in an organism and runs at a constant frequency throughout life [2]. Despite the impressive advancements made towards understanding more about the molecular basis of aging, there is still no serious considerations of gravity-clock that plays a key role in aging. The author's early paper [21] proposes that the gravity-clock of relativistic matter wave acts to regulate lifespan. This section simply reviews this important application of the quantum gravity theory.

In the Earth system, the moon is quantized by Earth's planetary-scale relativistic matter wave with the ultimate acceleration β=1.377075e+14(m/s^2) [21].

Human body consists of five parts: one head and four limbs, a heart pumps the blood to the whole body circularly. Consider a person sleeping in a bed with the head pointing to the North Pole, as shown in Fig.4(a), the five red lines from the heart represent its five artery tubes.

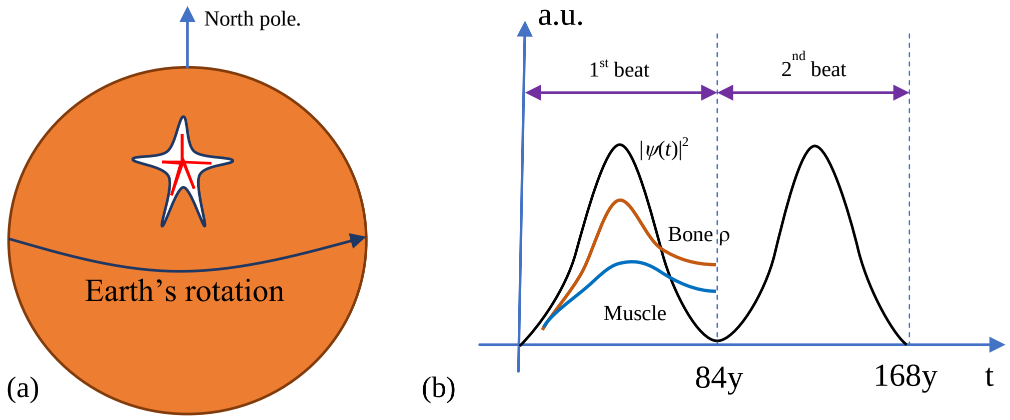

Fig.4 (a)A human sketch with the head pointing to the North Pole. (b) the biological gravity-clock.

Apparently, the arterial blood flows into the two arms with a speed, whose planetary-scale matter wave would interfere with the Earth's shell matter wave, producing a beat phenomenon:

$$|\psi|^2 = |\psi_{blood} + C\psi_{shell}|^2 = 1 + C^2 + 2C\cos[\frac{2\pi}{\lambda_{beat}}\int_L dl - \frac{2\pi}{T_{beat}}t] \qquad (27)$$

$$\frac{2\pi}{T_{beat}} =\simeq \frac{\beta}{c^3}(\frac{v_{blood}^2}{2} - \frac{v_{shell}^2}{2}); \quad \frac{2\pi}{\lambda_{beat}} = \frac{\beta}{c^3}(v_{blood} - v_{shell}); \quad v_{shell} = \omega r$$

where C represents the coupling coefficient, ω is the Earth's angular speed, r the Earth radius. The shell's ψ_{shell} is with spherical symmetry because the earth's density $\rho(r)$ is approximately spherical symmetry, so that this calculation carries out on the Earth's equator. The blood flow velocity varies with the location of blood vessels. The normal value of aortic valve orifice blood flow velocity in adults is 1.0-1.7m/s, and that in children is 1.2-1.8m/s. The flow velocity of carotid artery is less than 1.2m/s, the normal flow velocity of abdominal aorta is less than 1.8 m/s, and the normal flow velocity of inferior vena cava is 0.05-0.25m/s. Therefore, 1m/s is the order of magnitude of the blood velocities. Suppose the mean blood speed in human arms is 1m/s near the heart, in the Earth-orbital reference frame, the flowing blood suffers a beat with the period as the follows

$$\begin{aligned} &v_{shell} = r\omega = 463.8m/s; \quad v_{blood} = v_{shell} \pm 1m/s \\ &T_{beat} \simeq \frac{4\pi c^3}{\beta\left(v_{blood}{}^2 - v_{shell}{}^2\right)} = \pm 84\,(years); \quad \lambda_{beat} = 1.2e+12(m) \end{aligned} \quad . \tag{28}$$

```
<Clet2020 Script>// [9]
double beta,H,M,r,rc, rs, rot,v1,v2, Year,T,Lamda,V,a,b,x,y,w;
int main(){beta=1.377075e+14; H=SPEEDC*SPEEDC*SPEEDC/beta;
M=5.97237e24; rs=6.378e6; rot=2*PI/(24*3600); Year=24*3600*365.2422;
v1=rot*rs;v2=v1+1; a=v2*v2-v1*v1; T=4*PI*H/a;
T/=Year; Lamda=2*PI*H/(v2-v1); b=Lamda/(2*PI*rs);
TextAt(100,20,"v1=%f, v2=%f, T=%f, L=%e, b=%e",v1,v2,T,Lamda,b);
T=2*PI*H/v1;T/=0.86;TextAt(100,50,"T=%e",T);
}#v07=?>A
```

In fact, the blood is pumped from the heart into both the eastern arm and western arm in Fig.4(a), producing a positive beat and a negative beat in the two arms with the same period of 84 years, the two beats form an overall beat through the two arms. It is found that human mean lifespan is just confined within the single period duration, this beat period is recognized as the human biological **gravity-clock**. The beat wavelength λ is 30000 times the circumference of the earth, so its λ effects are hardly observed.

According to the explanation to ψ in the paper [21], the beat $|\psi|^2$ is proportional to the matter density.

$$|\psi|^2 \propto \rho \quad . \tag{29}$$

The $|\psi|^2$ oscillation of the beat in Fig.4(b) represents the variation of a human body density in his whole life confined within one beat period. The human bone density (red line) and muscle (blue line) in a human life vary as function of age, also responding to the $|\psi|^2$ oscillation, as shown in Fig.4(b). After astronauts entered the space station, the coupling between the astronauts and the earth's rotation decreased, and there was a significant decrease in bone density, indicating that the bone density of normal people on the earth's surface is strongly related to $|\psi|^2$.

Obviously, the human bone and muscle are irreversible for a life process, they also completely resist the human to enter into the second beat for obtaining a 168 years longevity. Perhaps, some soft animals or cells may enter multi-beat process for a longer life or immortal. Human life process is accumulated by many instantaneous activities, so the accumulation formula for calculating human lifespan T is

$$\int_0^T \frac{F(C)dt}{T_{beat}(t)} = \int_0^T \frac{F(C)\beta\left(v_{blood}{}^2 - v_{shell}{}^2\right)}{4\pi c^3} dt = 1 \quad . \tag{30}$$

where $F(C)$ is a function of the instantaneous coupling coefficient C.

This formula can also be applied to estimate animal lifespan. Wikipedia lists some long-lived creatures in the entry of " List of longest-living organisms " [14], for example, Harriet, a Galápagos tortoise, died at the age of 175 years in June 2006. Lin Wang, an Asian elephant, was the oldest elephant in the Taipei Zoo, he died on February 26, 2003 at 86 years. The oldest goat was McGinty who lived to the age of 22 years and 5 months until her death in November 2003 on Hayling Island, UK. The Greenland shark had been estimated to live to about 200 years. A goldfish named Tish lived for 43 years after being won at a fairground in 1956. Geoduck, a species of saltwater clam native to the Puget Sound, have been known to live more than 160 years. The longevity formula in this paper can cover these longevity animal examples.

For Mars, Jupiter, Saturn, Uranus, Neptune, their parameters (β, etc.) are collected in Ref. [6]. Regardless their atmospheres, using the above beat period formula, the human biological clocks on these planets are calculated, their beat periods are: Mars 8.6 years; Jupiter 10.6 years; Saturn 7.3 years; Uranus 1.04 years; Neptune 0.96 years.

4. Conclusions

In 3D space, a vector needs three basis vectors. It was found that the Lorentz force uses only two basis vectors, leaving the third basis vector as an undefined variable. It is put forward that the third basis vector and its component is able to serve as the quantum hidden variable. Gravitational force also has the similar hidden variable which is responsible for the quantum gravity effects. As an application of the hidden variable theory, it is found that human lifespan is determined by this quantum gravity, further calculation shows that human average lifespan is about 84 years.

References

[1] Carmona J.J., Michan S., (2016) Biology of Healthy Aging and Longevity, Rev Inves Clin. 68:7-16.
[2] Neill D., (2014) Evolution of lifespan, Journal of Theoretical Biology, 358:232–245.
[3] de Broglie, L. (1923) Waves and Quanta. Nature, 112, 540. https://doi.org/10.1038/112540a0
[4] de Broglie, L. (1925) Recherches sur la théorie des Quanta, Translated in 2004 by A. F. Kracklauer as De Broglie, Louis, on the Theory of Quanta. https://doi.org/10.1051/anphys/192510030022
[5] Carlip, S., Chiou, D., Ni, W. and Woodard, R. (2015) Quantum Gravity: A Brief History of Ideas and Some Prospects, International Journal of Modern Physics D, 24, Article ID: 1530028. https://doi.org/10.1142/S0218271815300281
[6] Cui, H.Y. (2021) Relativistic Matter Wave and Quantum Computer. Kindle eBook, Amazon, Seattle.
[7] NASA. https://solarscience.msfc.nasa.gov/interior.shtml
[8] Schneider, S.E. and Arny, T.T. (2018) Pathways to Astronomy. 5th Edition, McGraw-Hill Education, London.
[9] Clet Lab (2022) Clet: C Compiler. https://drive.google.com/file/d/1OjKqANcgZ-9V56rgcoMtOu9w4rP49sgN/view?usp=sharing
[10] Orbital Debris Program Office, (2018) History of On-Orbit Satellite Fragmentations. 15th Edition, National Aeronautics and Space Administration, Washington DC.
[11] Wright, D. (2007) Space Debris. Physics Today, 10: 35-40. https://doi.org/10.1063/1.2800252
[12] Tang, Z.-M., Ding, Z.-H., Dai, L.-D., Wu, J. and Xu, Z.-W. (2017) The Statistics Analysis of Space Debris in Beam Parking Model in 78˚ North Latitude Regions. Space Debris Research, 17:1-7.
[13] Cox, N. (2001) Allen's Astrophysical Quantities. 4th Edition, Springer-Verlag, Berlin. https://doi.org/10.1007/978-1-4612-1186-0

[14] wikipedia, https://en.wikipedia.org/wiki/List_of_longest-living_organisms#Animals
[15]H.J. Levin, (1997) Rest Heart Rate and Life Expectancy, J Am Coll Cardiol, 30(4):1104–6.
[16]R.S. Seymour, A.J. Blaylock, (2000) The Principle of Laplace and Scaling of Ventricular Wall Stress and Blood Pressure in Mammals and Birds, Physiological and Biochemical Zoology, 73(4):389–405,
[17]Z.C. Lian. et al. (2008) Natural lifespan of humans and animals, Medical Healthcare Apparatus, 111(5):4-6.
[18] T.H. Dawson, (2014) Allometric Relations and Scaling Laws for the Cardiovascular System of Mammals, Systems, 2:168-185; doi:10.3390/systems2020168
[19] Cui,H.Y. (2023) Moon Exploration for Human Lifespan 7500 Years on the Moon, viXra:2304.0075. https://vixra.org/abs/2304.0075
[20] Cui,H.Y. (2023) Determination of Solar Radius and Earth's Radius by Relativistic Matter Wave, Journal of Applied Mathematics and Physics, 11:1, DOI: 10.4236/jamp.2023.111006
[21] Cui,H.Y. (2023) Modelling of Human Lifespan -- Based on Quantum Gravity Theory with Ultimate Acceleration, viXra:2302.0121. https://vixra.org/abs/2302.0121