Ultimate Distance Causes Red Shift in All Directions

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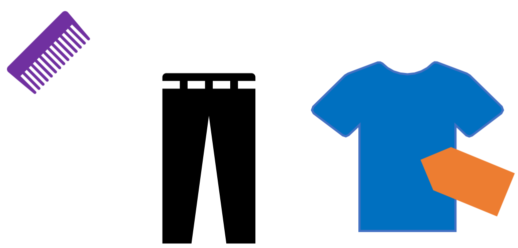
Abstract: In analogy with ultimate speed c, there is an ultimate acceleration β, nobody's acceleration can exceed this limit β, in the solar system β=2.961520e+10(m/s2). Because this ultimate acceleration is a large number, any effect connecting to β will become easy to test, including quantum gravity test. Similarly, there is an ultimate distance D, nobody can escape from this distance limit D. Where, ultimate distance D, ultimate speed c and ultimate acceleration β are three fundamental concepts that would provide us new insight into the world. By using ultimate acceleration and ultimate distance, this present paper suggests an approach to deal with cosmic red shifts and cosmic background radiation. The calculation results agree well with experimental observations.

1. Introduction

There is a class of effects that happen in all directions in the universe, for example, if we look only at distant galaxies by measuring their red shifts, we find an astonishing fact: They are all receding from us, in all directions! Another example, in 1965 A. Penzias and R. Wilson discovered a cosmic background radiation, generated in the early universe and filling all space almost uniformly, in all directions [9]. Since the Doppler effect depends on the direction between receiver and emitter, it is required to have a "huge electric iron" to smooth any fluctuations in all directions, so that fundamentally it is not suitable for explaining the Hubble law. In other words, the Doppler effect would be a wrong platform to bear human minds over the Hubble law.



smoothing the creases out with an electric iron

In analogy with ultimate speed c, there is an ultimate acceleration β, nobody's acceleration can exceed this limit β, in the solar system β=2.961520e+10(m/s^2). Because this ultimate acceleration is a large number, any effect connecting to β will become easy to test, including quantum gravity test. Similarly, there is an ultimate distance D, nobody can escape from this distance limit D. Where, ultimate distance D, ultimate speed c and ultimate acceleration β are three fundamental concepts that would provide us new insight into the world [27].

By using ultimate acceleration and ultimate distance, this present paper suggests an approach to deal with cosmic red shifts and cosmic background radiation. The calculation results agree well with experimental observations.

2. How to connect the ultimate acceleration with quantum gravity

In the relativity, the speed of light c is an ultimate speed, nobody's speed can exceed this limit c. The relativistic velocity u of a particle in the coordinate system ($x_1,x_2,x_3,x_4=ict$) satisfies

$$u_1^2+u_2^2+u_3^2+u_4^2=-c^2 \ . \tag{1}$$

No matter what particles (electrons, molecules, neutrons, quarks), their 4-vector velocities all have the same magnitude: $|u|=ic$. All particles gain **equality** because of the same magnitude of the 4-velocity u. The acceleration a of a particle is given by

$$a_1^2+a_2^2+a_3^2=a^2; \quad (a_4=0; \quad \because x_4=ict) \tag{2}$$

Assume that particles have an ultimate acceleration β as limit, no particle can exceed this acceleration limit β. Subtracting the both sides of the above equation by β^2, we have

$$a_1^2+a_2^2+a_3^2-\beta^2=a^2-\beta^2; \qquad a_4=0 \tag{3}$$

It can be rewritten as

$$[a_1{}^2+a_2{}^2+a_3{}^2+0+(i\beta)^2]\frac{1}{1-a^2/\beta^2}=-\beta^2 \tag{4}$$

Now, the particle subjects to an acceleration whose five components are specified by

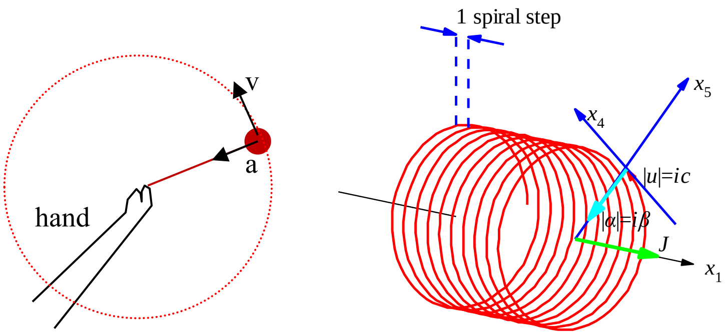
$$\begin{aligned}&\alpha_1=\frac{a_1}{\sqrt{1-a^2/\beta^2}}; \quad \alpha_2=\frac{a_2}{\sqrt{1-a^2/\beta^2}}; \\ &\alpha_3=\frac{a_3}{\sqrt{1-a^2/\beta^2}}; \quad \alpha_4=0; \quad \alpha_5=\frac{i\beta}{\sqrt{1-a^2/\beta^2}};\end{aligned} \tag{5}$$

where α_5 is the newly defined acceleration in five dimensional space-time ($x_1,x_2,x_3,x_4=ict,x_5$). Thus, we have

$$\alpha_1^2+\alpha_2^2+\alpha_3^2+\alpha_4^2+\alpha_5^2=-\beta^2; \quad \alpha_4=0 \tag{6}$$

It means that the magnitude of the newly defined acceleration α for every particle takes the same value: $|\alpha|=i\beta$ (constant imaginary number), all particle accelerations gain **equality** for the sake of the same magnitude.

How to resolve the velocity u and acceleration α into x, y, and z components? In realistic world, a hand can rotate a ball moving around a circular path at constant speed v with constant centripetal acceleration a, as shown in Fig.1(a).



(a) (b) right hand chirality

Fig.1 (a) A hand rotates a ball moving around a circular path at constant speed v with constant centripetal acceleration a. (b) The particle moves along the x_1 axis with the constant speed $|u|=ic$ in the u direction and constant centripetal force in the x_5 axis at the radius iR (imaginary number).

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<Clet2020 Script>// Clet is a C compiler [26]
double D[100],S[2000];int i,j,R,X,N;
int main(){R=50;X=50;N=600;D[0]=-50;D[1]=0;D[2]=0;D[3]=X;D[4]=0;D[5]=0;D[6]=-50;D[7]=R;D[8]=0;
D[9]=600;D[10]=10;D[11]=R;D[12]=0;D[13]=3645;
Lattice(SPIRAL,D,S);SetViewAngle(0,80,-50);DrawFrame(FRAME_NULL,1,0xffffff);
Draw("LINE,0,2,XYZ,0","-150,0,0,-50,0,0");Draw("ARROW,0,2,XYZ,10","50,0,0,150,0,0");
SetPen(2,0xff0000);Plot("POLYLINE,0,600,XYZ",S[9]);i=9+3*N-6;Draw("ARROW,0,2,XYZ,10",S[i]);
TextHang(S[i],S[i+1],S[i+2],"   #if|u|=ic#t");TextHang(150,0,0,"   #ifx#sd1#t");SetPen(2,0x005fff);
Draw("LINE,1,2,XYZ,8","-50,0,50,-50,0,100");Draw("LINE,1,2,XYZ,8","-40,0,50,-40,0,100");
Draw("ARROW,0,2,XYZ,10","-80,0,100,-50,0,100");Draw("ARROW,0,2,XYZ,10","-10,0,100,-40,0,100");
TextHang(-50,0,110,"1 spiral step");i=9+3*N;S[i]=50;S[i+1]=10;S[i+2]=10;
Draw("ARROW,0,2,XYZ,10","50,0,0,50,80,80");TextHang(50,80,80," #ifx#sd5#t");
Draw("ARROW,0,2,XYZ,10","50,72,0,50,0,72");TextHang(50,0,72,"   #ifx#sd4#t");
SetPen(3,0x00ffff);Draw("ARROW,0,2,XYZ,15",S[i-3]);TextHang(S[i],S[i+1],S[i+2],"   #if|α|=iβ#t");
SetPen(3,0x00ff00);Draw("ARROW,0,2,XYZ,15","50,0,0,120,0,0");TextHang(110,5,5," #ifJ#t");
TextHang(-60,0,-80," right hand chirality");}#v07=?>A
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In analogy with the ball in a circular path, consider a particle in one dimensional motion along the x_1 axis at the speed v, in the Fig.1(b) it moves with the constant speed $|u|=ic$ almost along the x_4 axis and slightly along the x_1 axis, and the constant centripetal acceleration $|\alpha|=i\beta$ in the x_5 axis at the constant radius iR (imaginary number); the coordinate system ($x_1,x_4=ict,x_5=iR$) establishes a cylinder coordinate system in which this particle moves spirally at the speed v along the x_1 axis. According to usual centripetal acceleration formula $a=v^2/r$, the acceleration in the x_4-x_5 plane is given by

$$a=\frac{v^2}{r} \quad \Rightarrow \quad i\beta=\frac{|u|^2}{iR}=-\frac{c^2}{iR}=i\frac{c^2}{R} \quad . \tag{7}$$

Therefore, the track of the particle in the cylinder coordinate system ($x_1,x_4=ict,x_5=iR$) forms a shape, called as **acceleration-roll**. The faster the particle moves along the x_1 axis, the longer the spiral step is.

As like a steel spring with elastic wave, the track in the acceleration-roll in Fig.1(b) can be described by a wave function whose phase changes 2π for one spiral step. Apparently, this wave is the de Broglie's matter wave for electrons, protons and quarks, etc.

Proof: The wave function phase changes 2π for one spiral circumference $2\pi(iR)$, then a small displacement of the particle on the spiral track is $|u|d\tau=icd\tau$ in the 4-vector u direction, thus this wave phase along the spiral track is evaluated by

$$phase=\int_0^{\tau}\frac{2\pi}{2\pi(iR)}icd\tau=\int_0^{\tau}\frac{c}{R}d\tau \quad . \tag{8}$$

Substituting the radius R into it, the wave function ψ is given by

$$\psi = \exp(-i \cdot phase) = \exp(-i\int_0^\tau \frac{c}{R} d\tau) = \exp(-i\frac{\beta}{c}\int_0^\tau d\tau) \quad . \tag{9}$$

In the theory of relativity, we known that the integral along $d\tau$ needs to transform into realistic line integral, that is

$$\begin{aligned} d\tau &= -c^2 \frac{d\tau}{-c^2} = (u_1^2 + u_2^2 + u_3^2 + u_4^2)\frac{d\tau}{-c^2} \\ &= (u_1 dx_1 + u_2 dx_2 + u_3 dx_3 + u_4 dx_4)\frac{1}{-c^2} \end{aligned} \quad . \tag{10}$$

Therefore, the wave function ψ is evaluated by

$$\begin{aligned} \psi &= \exp(-i\frac{\beta}{c}\int_0^\tau d\tau) \\ &= \exp(i\frac{\beta}{c^3}\int_0^x (u_1 dx_1 + u_2 dx_2 + u_3 dx_3 + u_4 dx_4)) \end{aligned} \quad . \tag{11}$$

This wave function may have different explanations, depending on the particle under investigation. If the β is replaced by the Planck constant for electrons, the wave function is given by

$$\begin{aligned} & assume: \quad \beta = \frac{mc^3}{\hbar} \\ & \psi = \exp(\frac{i}{\hbar}\int_0^x (mu_1 dx_1 + mu_2 dx_2 + mu_3 dx_3 + mu_4 dx_4)) \end{aligned} \quad . \tag{12}$$

where $mu_4dx_4=-Edt$, it strongly suggests that the wave function is just the de Broglie's matter wave [4,5,6].

In Fig.1(b), the acceleration-roll of particle moves with two distinctions: right-hand chirality and left-hand chirality. The direction of the angular momentum J would be slightly different from the x_1 due to spiral precession. It is easy to calculate the ultimate acceleration β, the radius R and the angular momentum J in the plane x_4-x_5 for a spiraling electron as

$$\begin{aligned} \beta &= \frac{c^3 m}{\hbar} = 2.327421\text{e+29}\ (\text{M/s}^2) \\ R &= \frac{c^2}{\beta} = 3.861593\text{e-13}\ (\text{M}) \\ J &= \pm m\,|\,u\,|\,iR = \mp\hbar \end{aligned} \quad . \tag{13}$$

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<Clet2020 Script>// Clet is a C compiler [26]
double beta,R,J,m,D[10];char str[200];
int main(){m=ME;beta=SPEEDC*SPEEDC*SPEEDC*m/PLANCKBAR;
R=SPEEDC*SPEEDC/beta;J=PLANCKBAR;Format(str,"beta=%e, #nR=%e, #nJ=%e",beta,R,J);
TextAt(50,50,str);ClipJob(APPEND,str);}#v07=#t
```

Considering another explanation to ψ for planets in the solar system, no Planck constant can be involved. But, in a many-body system with the total mass M, the data-analysis [28] tells us that the ultimate acceleration can be rewritten in terms of **Planck-constant-like constant** h as

$$\begin{aligned} & assume: \quad \beta = \frac{c^3}{hM} \\ & \psi = \exp\left(\frac{i}{hM}\int_0^x (u_1 dx_1 + u_2 dx_2 + u_3 dx_3 + u_4 dx_4)\right) \end{aligned} \quad . \tag{14}$$

The constant h will be determined by experimental observations. The papers [29,30] showed that this wave function is applicable to several many-body systems in the solar system, the wave function is called as the **acceleration-roll wave**.

Consider third explanation to ψ for atoms in cells and viruses. Typically, sound speed in water is v=1450m/s, according to $v=f\lambda$, the sound wavelength λ for frequency 1kHz---1Mhz is 1.5m---1.45mm. In general, the sound wavelength is larger than cell size, because cell size is about 1 micro. Thus, almost all cells and viruses live in a smaller space which is not sensitive to the sound. The acceleration-roll can provide a kind of wave with a shorter wavelength and lower frequency for various cells and viruses beyond human-sensitive sound wave [28].

Tip: actually, ones cannot get to see the acceleration-roll of a particle in the relativistic space-time ($x_1,x_2,x_3,x_4=ict$) ; only get to see it in the cylinder coordinate system ($x_1,x_4=ict,x_5=iR$).

3. How to connect the ultimate distance with cosmology

Position, velocity and acceleration are three basic concepts in particle physics, correspondingly, we have the position equality, the velocity equality, and the acceleration equality, respectively. The **position equality** admits there exists an **ultimate distance** D which is automatically recognized as the diameter of our universe: among the D rang nobody can escape. The position equality provides us a useful insight into cosmic microwave background, the Hubble law and dark matter.

Consider a star that have distance r to the sun (to us), we establish a frame of reference with the origin at the sun, as shown in Fig.2 in the Cartesian coordinates (x,y,z), the Pythagorean theorem tells us

$$x^2 + y^2 + z^2 = r^2 \tag{15}$$

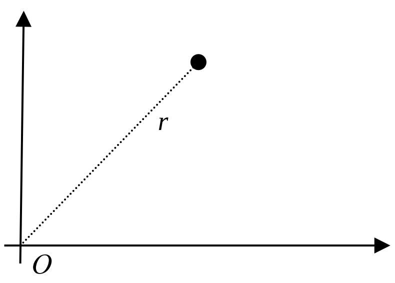


Fig.2 A star in the solar reference frame.

Because the distance is a very large quantity for the star, we worry about non-Euclidian effect that may involve within, we modify it as (Taylor expansion with the first order small quantity)

$$x^2 + y^2 + z^2 = r^2 + kr \tag{16}$$

where the kr term represents the possible non-Euclidian effect. Suppose there is the ultimate distance D in the universe, then we have

$$\begin{aligned} x^2+y^2+z^2-D^2 &= -D^2+r^2+kr \\ x^2+y^2+z^2-D^2 &= -D^2\left(1-\frac{kr}{D^2}-\frac{r^2}{D^2}\right) \end{aligned} \tag{17}$$

It can be rewritten as

$$\begin{aligned} &\left(\frac{x}{\sqrt{1-kr/D^2-r^2/D^2}}\right)^2+\left(\frac{y}{\sqrt{1-kr/D^2-r^2/D^2}}\right)^2 \\ &+\left(\frac{z}{\sqrt{1-kr/D^2-r^2/D^2}}\right)^2+\left(\frac{iD}{\sqrt{1-kr/D^2-r^2/D^2}}\right)^2=-D^2 \end{aligned} \tag{18}$$

Then, new coordinates can be established, are specified by

$$\begin{aligned} x' &= \frac{x}{\sqrt{1-kr/D^2-r^2/D^2}} \quad & y' &= \frac{y}{\sqrt{1-kr/D^2-r^2/D^2}} \\ z' &= \frac{z}{\sqrt{1-kr/D^2-r^2/D^2}} \quad & d' &= \frac{iD}{\sqrt{1-kr/D^2-r^2/D^2}} \end{aligned} \tag{19}$$

In the new coordinates (x',y',z',d'), all stars to the origin are the same for their same distance:

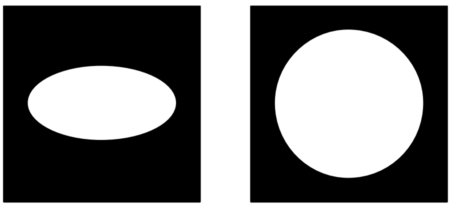
$$|x'^2+y'^2+z'^2+d'^2| = iD \tag{20}$$

The magnitude of the distance is a constant! It is in analogy with the velocity equality principle in the relativistic space-time. The new coordinates (x',y',z',d') is named as the **position equality space** in the followings. The above equation is called as the **position equality principle**.

Notice that a star moving at the classical position (x,y,z) will never be able escape from us in the position equality space (x',y',z',d'), simply because

$$\begin{aligned} x' &= \frac{x}{\sqrt{1-kr/D^2-r^2/D^2}} \quad \Rightarrow \quad |x'|<D \\ y' &= \frac{y}{\sqrt{1-kr/D^2-r^2/D^2}} \quad \Rightarrow \quad |y'|<D \\ z' &= \frac{z}{\sqrt{1-kr/D^2-r^2/D^2}} \quad \Rightarrow \quad |z'|<D \end{aligned} \tag{21}$$

In other words, all distance stars are confined in an equivalent cavity with the diameter D. Our universe is a blackbody cavity in terms of the position equality principle, in which all electromagnetic radiations warm up our universe, as shown in Fig.3.



classical cavity　　cavity confined by r≤D

Fig.3　A classical cavity, and an equivalent cavity confined by $r<D$ in the position equality space (x',y',z',d').

<Clet2020 Script>//[26]

```
int i,j,k,nP[10];
double r,x,y,z,dP[10],D[10];
int main(){DrawFrame(FRAME_NULL,1,0xafffaf); r=40;x=-50;D[0]=x-r;D[1]=-r;D[2]=x+r;D[3]=r;
SetPen(1,0x000000); Draw("RECT,1,2,XY,10",D); x=50;r=40;D[0]=x-r;D[1]=-r;D[2]=x+r;D[3]=r;
Draw("RECT,1,2,XY,10",D); r=30;x=-50;D[0]=x-r;D[1]=-r/2;D[2]=x+r;D[3]=r/2;
Draw("ELLIPSE,3,2,XY,0xffffff",D); r=30;x=50;D[0]=x-r;D[1]=-r;D[2]=x+r;D[3]=r;
Draw("ELLIPSE,3,2,XY,0xffffff",D);
TextHang(-x-x,-x,0,"classical cavity");TextHang(0,-x,0,"cavity confined by r<D");
}#v07=?>A
```

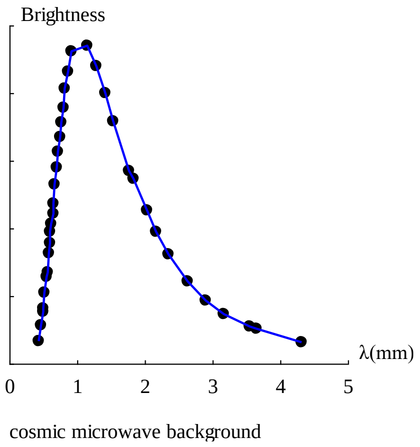


Fig.4 The measurement of the cosmic microwave background.

```
<Clet2020 Script>//[26]
int i,j,k,nP[10];char str[100]; double
D[74]={0.44,6.53,0.48,11.04,0.51,15.09,0.51,16.17,0.53,21.00,0.56,25.51,0.57,26.91,0.59,32.50,0.60,35.46,0.61,38.72,0.62,41.0
6,0.65,44.32,0.66,47.28,0.68,52.88,0.70,57.85,0.72,62.36,0.76,66.87,0.77,71.07,0.80,75.43,0.83,81.18,0.87,86.31,0.93,92.07,1.1
6,93.78,1.29,87.87,1.42,79.94,1.54,71.54,1.78,56.92,1.84,54.43,2.04,45.26,2.18,38.72,2.36,32.19,2.64,24.11,2.90,18.66,3.17,14.
62,3.56,10.73,3.65,10.11,4.33,6.22,};
int main(){ SetAxis(X_AXIS,0,0,5,"λ(mm);0;1;2;3;4;5;");SetAxis(Y_AXIS,0,0,100,"Brightness;;;;;;;");
DrawFrame(FRAME_SCALE,1,0xafffaf); Plot("OVALFILL,0,37,XY,5,5,",D);
SetPen(2,0x0000ff); Polyline(37,D); TextHang(0,-20,0,"cosmic microwave background");
}#v07=?>A
```

According to the blackbody theory, our universe has a mean temperature T with a standard blackbody spectrum in the cavity $r<D$, experimental observations confirmed the profile of cosmic microwave background radiation to be an exact blackbody radiation spectrum at the temperature T=2.725K, as shown in Fig.4.

Now, let us test the position equality principle using the Hubble law. Consider an atom at far distance $x=r$, emitting an electromagnetic wave of wavelength λ. We must hold the position equality principle for all stars, so actually we live in the new coordinate system (x',y',z',d'), what we see is

$$
\begin{aligned}
x' &= \frac{x}{\sqrt{1-kr/D^2-r^2/D^2}} \qquad dx' \simeq (1+\frac{kr}{2D^2})dx \\
y' &= y = 0 \\
z' &= z = 0 \\
d' &= \frac{iD}{\sqrt{1-kr/D^2-r^2/D^2}}
\end{aligned}
\tag{22}
$$

Thus, we at the origin receive the wave length λ' of the electromagnetic wave as

$$
\lambda' \simeq (1+\frac{kr}{2D^2})\lambda \tag{23}
$$

This is the Hubble law for far stars, the $2D^2/k$ equals to the Hubble constant, in fact the Hubble law happens in all directions in the sky like cosmic microwave background in all directions. The advantage of the position equality principle is that it is not necessary for stars to recede as the prediction by the Doppler effect theory for frequency shift. For last many decades, our vision to the cosmology has been misguided by abuse of the Doppler effect for electromagnetic wave over the Hubble law, the later leads to the expansion of the universe and the big bang. Now, sleeping with the position equality principle, it is time for the universe to become quiet [28].

4. How to determine the ultimate acceleration and ultimate distance

In the preceding section, we have defined the generalized matter wave as the acceleration-roll wave in the solar system.

In a many-body system with the total mass M, a constituent particle has the mass m and moves at the speed v, its wavelength of matter wave is modified in Eq.(14) as

$$\lambda_{de\_Broglie} = \frac{2\pi\hbar}{mv} \Rightarrow \text{modify} \Rightarrow \quad \lambda = \frac{2\pi h M}{v}; \quad h = \frac{c^3}{M\beta} \quad . \tag{24}$$

where h is a **Planck-constant-like constant**. It is found that this modified matter wave works for quantizing planetary orbits correctly [28,29].

In the Bohr's orbit model, as shown in Fig.5, the circular quantization condition is given by

$$\left.\begin{array}{l} 2\pi r = n\lambda \\ v = \sqrt{\dfrac{GM}{r}} \end{array}\right\} \Rightarrow \quad \sqrt{r} = h\sqrt{\frac{M}{G}}n; \quad or \quad \sqrt{r} = \frac{c^3}{\beta\sqrt{GM}}n \tag{25}$$

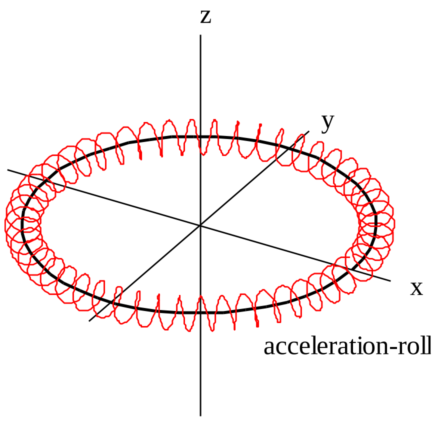


Fig.5 A planet 2D orbit around the sun, an acceleration-roll winding around the planet.

```
<Clet2020 Script>//[26]
int i,j,k; double r,rot,x,y,z,D[20],F[20],S[200];
int main(){SetViewAngle("temp0,theta60,phi-30");
DrawFrame(FRAME_LINE,1,0xafffaf);r=80;Spiral(); TextHang(r,-r,0,"acceleration-roll");
r=110;TextHang(r,0,0,"x");TextHang(0,r,0,"y");TextHang(0,0,r,"z");}
Spiral(){r=80;j=10;rot=j/r;k=2*PI/rot+1;
for(i=0;i<k;i+=1) {D[0]=x;D[1]=y;D[2]=z;D[6]=x;D[7]=y;D[8]=r;
x=r*cos(rot*i);y=r*sin(rot*i);z=0;if(i==0) continue;
SetPen(2,0x00);F[0]=D[0];F[1]=D[1];F[2]=x;F[3]=y;Draw("LINE,0,2,XY,",F);SetPen(1,0xff0000);
D[3]=x;D[4]=y;D[5]=z; D[9]=40;D[10]=10;D[11]=8;D[12]=0;D[13]=360;
Lattice(SPIRAL,D,S);Plot("POLYLINE,0,40,XYZ",S[9]);}
}#v07=?>A
```

It indicates that there is a linear relation between the square root of radius and the quantum number n. The solar system, Jupiter's satellites, Saturn's satellites, Uranus' satellites, Neptune's satellites as five different many-body systems are investigated with the Bohr's orbit model. After fitting observational data, the Planck-constant-like constant h is obtained in Table 1, respectively, the predicted quantization in Fig.6(a), Fig.6(b), Fig.6(c), Fig.6(d) and Fig.6(e) agrees well with experimental observations for those inner constituent particles. The key point is that the various systems have almost same Planck-constant-like constant h in Table 1 with a mean value of 3.51e-16 $m^2s^{-1}kg^{-1}$, at least have the same magnitude!

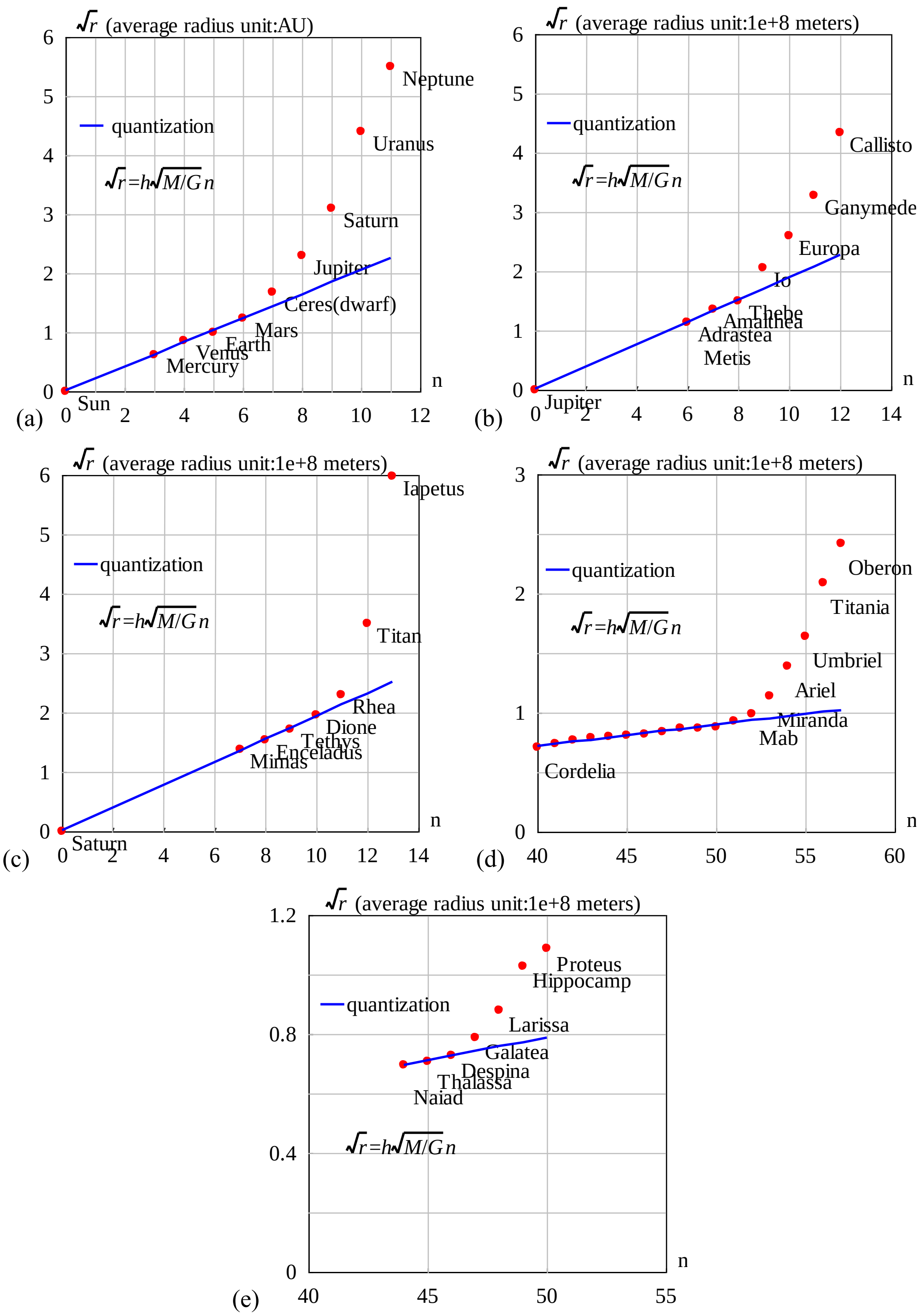


Fig.6 The orbital radii are quantized for inner constituents. (a) the solar system with h=4.574635e-16 ($m^2s^{-1}kg^{-1}$). The relative error is less than 3.9%. (b) the Jupiter system with h=3.531903e-16 ($m^2s^{-1}kg^{-1}$). Metis and Adrastea are assigned the same quantum number for their almost same radius. The relative error is less than 1.9%.(c) the Saturn system with h=6.610920e-16 ($m^2s^{-1}kg^{-1}$). The relative error is less than 1.1%.(d) the Uranus system with

h=1.567124e-16 ($m^2s^{-1}kg^{-1}$). n=0 is assigned to the Uranus. The relative error is less than 2.5%.(e) the Neptune system with h=1.277170e-16 ($m^2s^{-1}kg^{-1}$). n=0 is assigned to the Neptune. The relative error is less than 0.17%.

Table 1 Planck-constant-like constant h, N is constituent particle number with smaller inclination.

system	N	M/M_{earth}	β (m/s^2)	h ($m^2s^{-1}kg^{-1}$)	Prediction
Solar planets	9	333000	2.961520e+10	4.574635e-16	Fig.6(a)
Jupiter' satellites	7	318	4.016793e+13	3.531903e-16	Fig.6(b)
Saturn's satellites	7	95	7.183397e+13	6.610920e-16	Fig.6(c)
Uranus' satellites	18	14.5	1.985382e+15	1.567124e-16	Fig.6(d)
Neptune 's satellites	7	17	2.077868e+15	1.277170e-16	Fig.6(e)

In Fig.6(a), the blue straight line expresses the linear regression relation among the Sun, Mercury, Venus, Earth and Mars, their quantization parameters are hM=9.098031e+14(m^2/s). The ultimate acceleration is β=2.961520e+10 (m/s^2). The quantization linear regression relation is independent from individual planetary mass and size.

Because the ultimate distance was regarded as an issue which deeply concerns with the dark matter in the universe [28], it would be left to be determined in the coming study on the dark matter.

5. Conclusions

In analogy with ultimate speed c, there is an ultimate acceleration β, nobody's acceleration can exceed this limit β, in the solar system β=2.961520e+10(m/s^2). Because this ultimate acceleration is a large number, any effect connecting to β will become easy to test, including quantum gravity test. Similarly, there is an ultimate distance D, nobody can escape from this distance limit D. Where, ultimate distance D, ultimate speed c and ultimate acceleration β are three fundamental concepts that would provide us new insight into the world. By using ultimate acceleration and ultimate distance, this present paper suggests an approach to deal with cosmic red shifts and cosmic background radiation. The calculation results agree well with experimental observations.

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