Modelling of Human Lifespan:

Based on Quantum Gravity Theory with Ultimate Acceleration

Huaiyang Cui
Department of Physics, Beihang University, Beijing, 102206, China
Email: hycui@buaa.edu.cn
(Feb 24, 2023 version 1, September 5,2023 version 2, submitted to viXra)

Abstract: Rather than biological time being controlled solely by a molecular cascade domino effect, this paper suggests that the gravity-clock of planetary-scale relativistic matter wave acts to regulate lifespan. It is found that the 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. According to the gravity-clock concept, the period of sunspot cycle is calculated to be 10.95 years, the human lifespan on the Earth is calculated to be 84 years. The lifespan model is applicable to a variety of animals, it predicts that the total number of heart beats/lifetime among mammals and birds is remarkably constant: 3e+9 (beats/lifetime), the conclusion has been confirmed by the observations of 34 species of mammals and birds.

Key words: matter wave, gravity-clock, lifespan

1. Introduction

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. This paper proposes that the gravity-clock of relativistic matter wave acts to regulate lifespan.

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

$$\psi = \exp\left(\frac{i\beta}{c^3}\int_0^x (u_1 dx_1 + u_2 dx_2 + u_3 dx_3 + u_4 dx_4)\right) \quad . \tag{1}$$

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, this paper shows 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. It predicts that the total number of heart beats/lifetime among mammals and birds is remarkably constant: 3e+9 (beats/lifetime), this conclusion has been confirmed by the observations of 34 species of mammals and birds.

2. Extracting ultimate acceleration from the solar system

In the orbital model as shown in Fig.1(a), the orbital circumference is *n* multiple of the wavelength of the planetary-scale relativistic matter wave, according to Eq. (1), consider a planet, we have

$$\left.\begin{aligned} \frac{\beta}{c^3}\oint_L v_l dl = 2\pi n \\ v_l = \sqrt{\frac{GM}{r}} \end{aligned}\right\} \Rightarrow \sqrt{r} = \frac{c^3}{\beta\sqrt{GM}}n; \quad n = 0,1,2,\ldots \quad . \tag{2}$$

This orbital quantization rule achieves only a half success in the solar system, as shown in Fig.1(b), the Sun, Mercury, Venus, Earth and Mars satisfy the quantization equation; while other outer planets fail. But, since we only study quantum gravity effects among the Sun, Mercury, Venus, Earth and Mars, so this orbital quantization rule is good enough as a foundational quantum theory. In Fig.1(b), the blue straight line expresses a linear regression relation among the quantized orbits, so it gives β=2.956391e+10 (m/s^2) by fitting the line. The quantum numbers n=3,4,5,... were assigned to the solar planets, the sun was assigned a quantum number n=0 because the sun is in the **central state**.

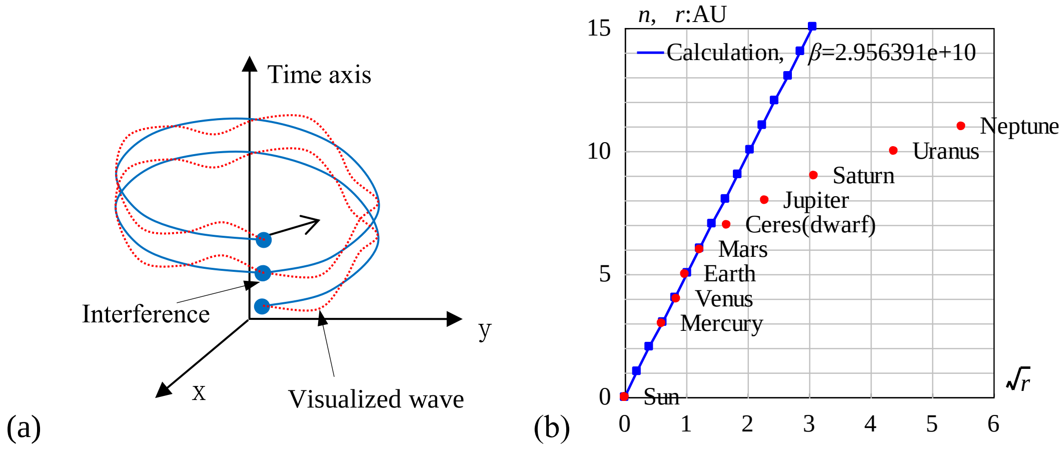

Fig.1 (a)The head of the relativistic matter wave may overlap with its tail. (b) The inner planets are quantized.

The planetary-scale relativistic matter wave can be applied to determine the solar density and radius. In a central state, if the coherent length of the relativistic matter wave is long enough, its head may overlap with its tail when the particle moves in a closed orbit, as shown in Fig.1(a). Consider a point on the solar equatorial plane, the overlapped wave is given by

$$\begin{aligned}
&\psi=\psi(r)T(t)\\
&\psi(r)=1+e^{i\delta}+e^{i2\delta}+\ldots+e^{i(N-1)\delta}=\frac{1-\exp(iN\delta)}{1-\exp(i\delta)}\quad . \\
&\delta(r)=\frac{\beta}{c^3}\oint_L (v_l)dl=\frac{2\pi\beta\omega r^2}{c^3}
\end{aligned}\tag{3}$$

where N is the overlapping number which is determined by the coherent length of the relativistic matter wave, δ is the phase difference after one orbital motion, ω is the angular speed of the solar self-rotation. The above equation is the multi-slit interference formula in optics, for a larger N it is called as the Fabry-Perot interference formula.

The planetary-scale relativistic matter wave function ψ needs a further explanation. In quantum mechanics, $|\psi|^2$ equals to the probability of finding an electron due to Max Born's explanation; in astrophysics, $|\psi|^2$ equals to the probability of finding a nucleon (proton or neutron) *averagely on an astronomic scale*, we have

$$|\psi|^2 \propto \text{nucleon-density} \propto \rho\ . \tag{4}$$

It follows from the multi-slit interference formula that the overlapping number N is estimated by

$$N^2=\frac{|\psi(0)_{multi-wavelet}|^2}{|\psi(0)_{one-wavelet}|^2}=\frac{\rho_{core}}{\rho_{surface\_gas}}\quad . \tag{5}$$

The solar core has a mean density of 1408 (kg/m^3), the surface of the sun is comprised of convective zone with a mean density of 2e-3 (kg/m^3) [7]. In this paper, the sun's radius is chosen at a location where density is 4e-3 (kg/m^3), thus the solar overlapping number N is calculated to be N=593. Since the mass density ρ has spherical symmetry, then the $\psi(r)$ has the spherical symmetry.

Sun's angular speed at its equator is known as ω=2π/(25.05x24x3600) (s^{-1}). Its mass 1.9891e+30 (kg), well-known radius 6.95e+8 (m), mean density 1408 (kg/m^3), the constant β=2.956391e+10 (m/s^2). According to the N=593, the matter distribution of the $|\psi|^2$ is calculated in Fig.2(a), it agrees well with the general description of star's interior [8]. The radius of the sun is determined as r=7e+8 (m) with a relative error of 0.72% in Fig.2, which indicates that the sun radius strongly depends on the sun's self-rotation.

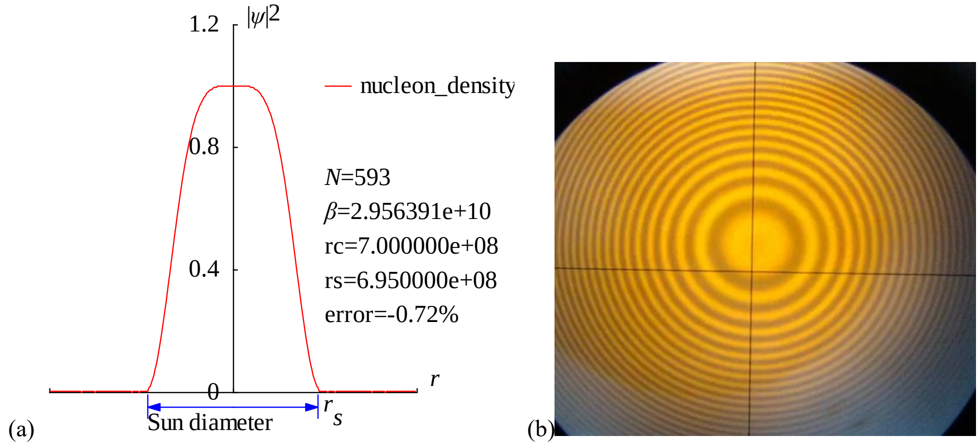

Fig.2 (a)The nucleon distribution $|\psi|^2$ in the Sun is calculated in the radius direction. (b) As contrast, sodium Fabry-Perot interference (δ=const.).

```
<Clet2020 Script>//C source code [9]
int i,j,k,m,n,N,nP[10];
double beta,H,B,M,r,r_unit,x,y,z,delta,D[1000],S[1000], a,b,rs,rc,omega,atm_height; char str[100];
main(){k=150;rs=6.95e8;rc=0;x=25.05;omega=2*PI/(x*24*3600);n=0; a=1408/0.004; N=sqrt(a);
beta=2.956391e10;H=SPEEDC*SPEEDC*SPEEDC/beta;M=1.9891E30; atm_height=2e6; r_unit=1E7;
for(i=-k;i<k;i+=1) {r=abs(i)*r_unit;
if(r<rs+atm_height) delta=2*PI*omega*r*r/H; else delta=2*PI*sqrt(GRAVITYC*M*r)/H;//around the star
x=1;y=0; for(j=1;j<N;j+=1) { z=delta*j; x+=cos(z);y+=sin(z);} z=x*x+y*y; z=z/(N*N);
S[n]=i;S[n+1]=z; if(i>0 && rc==0 && z<0.0001) rc=r; n+=2;}
SetAxis(X_AXIS,-k,0,k,"#ifr; ; ; ;");SetAxis(Y_AXIS,0,0,1.2,"#if|ψ|#su2#t;0;0.4;0.8;1.2;");
DrawFrame(FRAME_SCALE,1,0xafffaf); z=100*(rs-rc)/rs;
SetPen(1,0xff0000);Polyline(k+k,S,k/2,1," nucleon_density"); SetPen(1,0x0000ff);
r=rs/r_unit;y=-0.05;D[0]=-r;D[1]=y;D[2]=r;D[3]=y; Draw("ARROW,3,2,XY,10,100,10,10,",D);
Format(str,"#ifN#t=%d#n#ifβ#t=%e#nrc=%e#nrs=%e#nerror=%.2f%",N,beta,rc,rs,z);
TextHang(k/2,0.7,0,str);TextHang(r+5,y/2,0,"#ifr#sds#t");TextHang(-r,y+y,0,"Sun diameter");
}#v07=?>A
```

3. Extracting ultimate acceleration from the earth

The moon is assigned a quantum number of n=2 because some quasi-satellite's perigees have reached a depth almost at n=1 orbit, as shown in Fig.3. Here, the ultimate acceleration β=1.377075e+14(m/s^2) is determined uniquely by the line between the earth and moon by Eq. (2).

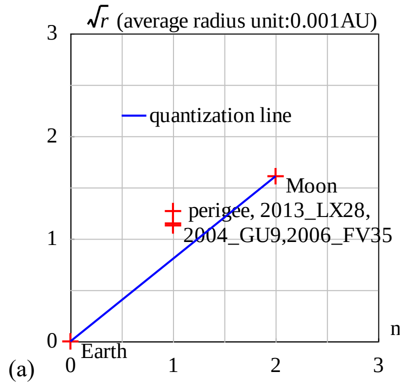

Fig.3 Orbital quantization for the moon.

The earth has a mean density of 5530 (kg/m^3), its surface is covered with air and vapor with a density of 1.29 (kg/m^3). The earth's radius is chosen at the sea level, it follows Eq.(5) that the earth's overlapping number N is calculated to be N=65.

The earth's angular speed is known as ω=2π/(24x3600) (s^{-1}), its mass 5.97237e+24 (kg), the well-known radius is 6.378e+6 (m), the earth's constant β=1.377075e+14 (m/s^2). The matter distribution $|\psi|^2$ in radius direction is calculated by Eq.(3), as shown in Fig.4(a). The radius of the earth is determined as r=6.4328e+6 (m) with a relative error of 0.86%, it agrees well with common knowledge. The secondary peaks over the atmosphere up to 2000 km altitude are calculated in Fig.4(b) which agree well with the space debris observations [10][11][12].

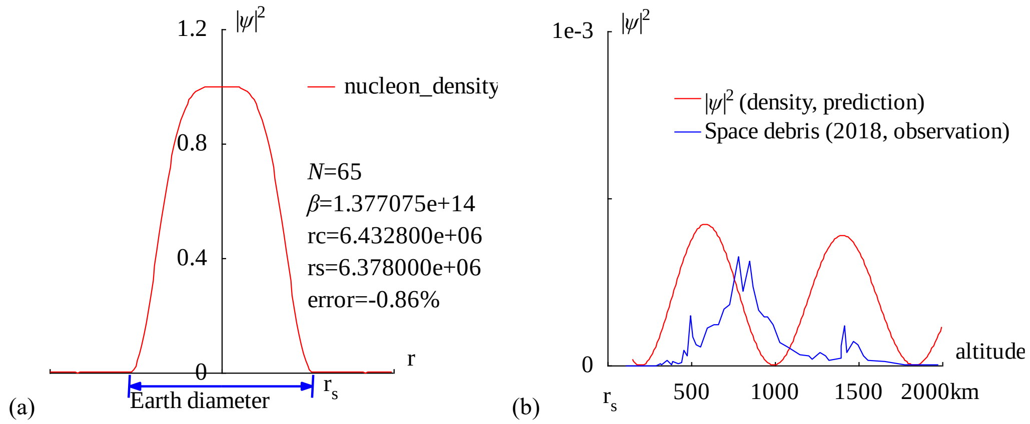

Fig.4 (a) The radius of the Earth is calculated out r=6.4328e+6 (m) with a relative error of 0.86% by the interference of its relativistic matter wave; (b) The space debris distribution up to 2000 km altitude.

```
<Clet2020 Script>//C source code [9]
int i,j,k,m,n,N,nP[10]; double H,B,M,v_r,r,AU,r_unit,x,y,z,delta,D[10],S[1000];
double rs,rc,rot,a,b,atm_height,beta; char str[100];
main(){k=80;rs=6.378e6;rc=0;atm_height=1.5e5;n=0; N=65;
beta=1.377075e+14;H=SPEEDC*SPEEDC*SPEEDC/beta;
M=5.97237e24;AU=1.496E11;r_unit=1e-6*AU; rot=2*PI/(24*60*60);//angular speed of the Earth
for(i=-k;i<k;i+=1) {r=abs(i)*r_unit;
if(r<rs+atm_height) v_r=rot*r*r; else v_r=sqrt(GRAVITYC*M*r);//around the Earth
delta=2*PI* v_r/H; y=SumJob("SLIT_ADD,@N,@delta",D); y=y/(N*N);
if(y>1) y=1; S[n]=i;S[n+1]=y; if(i>0 && rc==0 && y<0.001) rc=r;    n+=2;}
SetAxis(X_AXIS,-k,0,k,"r; ; ; ;");SetAxis(Y_AXIS,0,0,1.2,"#if|ψ|#su2#t;0;0.4;0.8;1.2;");
DrawFrame(FRAME_SCALE,1,0xafffaf); x=50;z=100*(rs-rc)/rs;
SetPen(1,0xff0000);Polyline(k+k,S,k/2,1," nucleon_density");
r=rs/r_unit;y=-0.05;D[0]=-r;D[1]=y;D[2]=r;D[3]=y;
SetPen(2,0x0000ff); Draw("ARROW,3,2,XY,10,100,10,10,",D);
Format(str,"#ifN#t=%d#n#ifβ#t=%e#nrc=%e#nrs=%e#nerror=%.2f%",N,beta,rc,rs,z);
TextHang(k/2,0.7,0,str);TextHang(r+5,y/2,0,"r#sds#t");TextHang(-r,y+y,0,"Earth diameter");
}#v07=?>A#t
<Clet2020 Script>//C source code [9]
int i,j,k,m,n,N,nP[10]; double H,B,M,v_r,r,AU,r_unit,x,y,z,delta,D[10],S[10000];
double rs,rc,rot,a,b,atm_height,p,T,R1,R2,R3; char str[100]; int
Debris[96]={110,0,237,0,287,0,317,2,320,1,357,5,380,1,387,4,420,2,440,3,454,14,474,9,497,45,507,26,527,19,557,17,597,34,63
4,37,664,37,697,51,727,55,781,98,808,67,851,94,871,71,901,50,938,44,958,44,991,37,1028,21,1078,17,1148,10,1202,9,1225,6,
1268,12,1302,9,1325,5,1395,7,1395,18,1415,36,1429,12,1469,22,1499,19,1529,9,1559,5,1656,4,1779,1,1976,1,};
main(){k=80;rs=6.378e6;rc=0;atm_height=1.5e5;n=0; N=65;
H=1.956611e11;M=5.97237e24;AU=1.496E11;r_unit=1e4;
rot=2*PI/(24*60*60);//angular speed of the Earth
b=PI/(2*PI*rot*rs*rs/H); R1=rs/r_unit;R2=(rs+atm_height)/r_unit;R3=(rs+2e6)/r_unit;
for(i=R2;i<R3;i+=1) {r=abs(i)*r_unit; delta=2*PI*sqrt(GRAVITYC*M*r)/H;
y=SumJob("SLIT_ADD,@N,@delta",D); y=1e3*y/(N*N);// visualization scale:1000
if(y>1) y=1; S[n]=i;S[n+1]=y;n+=2;}
SetAxis(X_AXIS,R1,R1,R3,"altitude; r#sds#t;500;1000;1500;2000km ;");
SetAxis(Y_AXIS,0,0,1,"#if|ψ|#su2#t;0; ;1e-3;");DrawFrame(FRAME_SCALE,1,0xafffaf); x=R1+(R3-R1)/5;
SetPen(1,0xff0000);Polyline(n/2,S,x,0.8,"#if|ψ|#su2#t (density, prediction)");
for(i=0;i<48;i+=1) {S[i+i]=R1+(R3-R1)*Debris[i+i]/2000; S[i+i+1]=Debris[i+i+1]/300;}
SetPen(1,0x0000ff);Polyline(48,S,x,0.7,"Space debris (2018, observation) "); }#v07=?>A#t
```

4. The first example of gravity-clock concept: Sunspot cycle

The **coherence length** of waves is usually mentioned but the **coherence width** of waves is rarely discussed in quantum mechanics, simply because the latter is not a matter for electrons, nucleon, or photons, but it is a matter in astrophysics. The analysis of observation data tells us that on the planetary scale, the coherence width of planetary-scale relativistic matter waves can extend to 1000 kilometers or more, as illustrated in Fig.5(a), the overlap may even occur in the orbital width direction, thereby bringing new aspects to wave interference.

In the solar convective zone, adjacent convective rings form a top-layer flow, a middle-layer gas, and a ground-layer flow. Considering one convective ring at the equator as shown in Fig.5(b), there is an apparent velocity difference between the top-layer flow and the middle-layer gas, where their planetary-scale relativistic matter waves are denoted respectively by

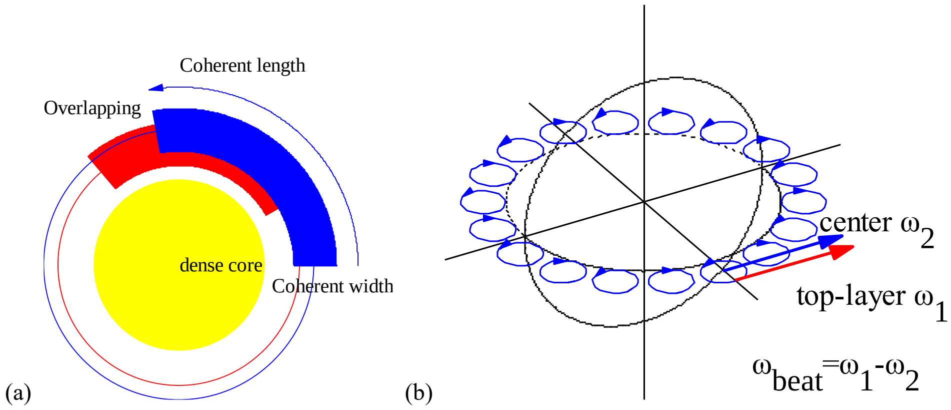

Fig.5 (a) Illustration of overlapping in the coherent width direction. (b) Convective rings at the equator.

$$\begin{aligned} &\psi = \psi_{top} + C\psi_{middle} \\ &\psi_{top} = \exp[\frac{i\beta}{c^3}\int_L (v_1 dl + \frac{-c^2}{\sqrt{1-v_1^2/c^2}}dt)] \\ &\psi_{middle} = \exp[\frac{i\beta}{c^3}\int_L (v_2 dl + \frac{-c^2}{\sqrt{1-v_2^2/c^2}}dt)] \end{aligned} \quad . \qquad (6)$$

Their interference in the coherent width direction leads to a beat phenomenon

$$\begin{aligned} &|\psi|^2 = |\psi_{top} + C\psi_{middle}|^2 = 1 + C^2 + 2C\cos[\frac{2\pi}{\lambda_{beat}}\int_L dl - \frac{2\pi}{T_{beat}}t] \\ &\frac{2\pi}{T_{beat}} = \frac{\beta}{c^3}(\frac{c^2}{\sqrt{1-v_1^2/c^2}} - \frac{c^2}{\sqrt{1-v_2^2/c^2}}) \simeq \frac{\beta}{c^3}(\frac{v_1^2}{2} - \frac{v_2^2}{2}) \\ &\frac{2\pi}{\lambda_{beat}} = \frac{\beta}{c^3}(v_1 - v_2) \end{aligned} \quad . \qquad (7)$$

Their speeds are calculated as

$$\begin{aligned} &v_1 \approx 6100\,(m/s) \quad (\approx \text{observed in Evershed flow}) \\ &v_2 = \omega r_{middle} = 2017\,(m/s) \quad (\text{solar rotation}); \end{aligned} \quad . \qquad (8)$$

Where, regarding the Evershed flow as the eruption of the top-layer flow, about 6 (km/s) speed was reported [13]. Alternatively, the top-layer speed v_1 also can be calculated in terms of thermodynamics, to be v_1=6244 (m/s) [6]. Here using v_1=6100 (m/s), their beat period T_{beat} is calculated to be a value of 10.95 (years), in agreement with the sunspot cycle value (say, mean 11 years).

$$T_{beat} \simeq \frac{4\pi c^3}{\beta\left(v_1^2 - v_2^2\right)} = 10.95\,(years) \ . \qquad (9)$$

```
<Clet2020 Script>// [9]
double beta,H,M,N,dP[20],D[2000],r,rs,rot,x,y,v1,v2,K1,K2,T1,T2,T,Lamda,V; int i,j,k,s;
int main(){beta=2.956391e10; H=SPEEDC*SPEEDC*SPEEDC/beta;
M=1.9891E30; rs=6.95e8;rot=2*PI/(25.05*24*3600);v1=rot*rs;K1=v1*v1/2;//T1=2*PI*H/K1;
v2=6100; K2=v2*v2/2;T2=2*PI*H/(K2-K1);T=T2/24*3600*365.2422;
```

```
Lamda=2*PI*H/(v2-v1);V=Lamda/T2;s=1;
SetViewAngle("temp0,theta60,phi-60");
DrawFrame(FRAME_LINE,1,0xafffaf);Overlook("2,1,60", D);
TextAt(10,10,"v1=%d, v2=%d, T=%.2f y, λ=%e, V=%d",v1,v2,T, Lamda,V);
SetPen(1,0x4f4fff); for(i=0;i<18;i+=1) {v1=i*2*PI/18; x=70*cos(v1);y=70*sin(v1);Ring();}
SetPen(2,0xff0000);Draw("ARROW,0,2,XYZ,15","80,0,0,80,60,0");
TextHang(100,20,0,"top-layer ω#sd1#t"); SetPen(2,0x0000ff);
Draw("ARROW,0,2,XYZ,15","70,0,0,70,60,0");
TextHang(50,60,0,"center ω#sd2#t");TextHang(140,-30,0," ω#sdbeat#t=ω#sd1#t-ω#sd2#t");
}
Ring(){ k=0;N=20; r=10;
for(j=0;j<N+2;j+=1) {k=j+j+j; v2=s*j*2*PI/N; D[k]=x+r*cos(v2);D[k+1]=y+r*sin(v2); D[k+2]=0;}
Plot("POLYLINE,4,22,XYZ,8",D)s*=-1;}
#v07=?>A
```

The relative error to the mean 11 years is 0.6% for the beat period calculation using the planetary-scale relativistic matter waves. This beat phenomenon turns out to be a **nucleon density oscillation** that undergoes to drive the sunspot cycle evolution with a **gravity-clock**. The beat wavelength λ_{beat} is too long to observe, only the beat period (gravity-clock) is easy to be observed.

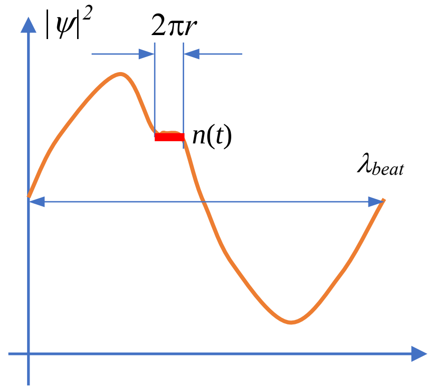

Fig.6 The equatorial circumference 2πr only occupies a little part of the beat wavelength, what we see is the expansion and contraction of the nucleon density.

As shown in Fig.6, on the solar surface, the equatorial circumference $2\pi r$ only occupies a little part of the beat wavelength, what we see is the expansion and contraction of the nucleon density.

$$\frac{2\pi r}{\lambda_{beat}} = 0.0031 \quad . \tag{10}$$

This nucleon density oscillation is understood as a new type of nuclear reaction on an astronomic scale.

5. Human lifespan controlled by relativistic gravity-clock

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) in the section 3.

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.7(a), the five red lines from the heart represent its five artery tubes.

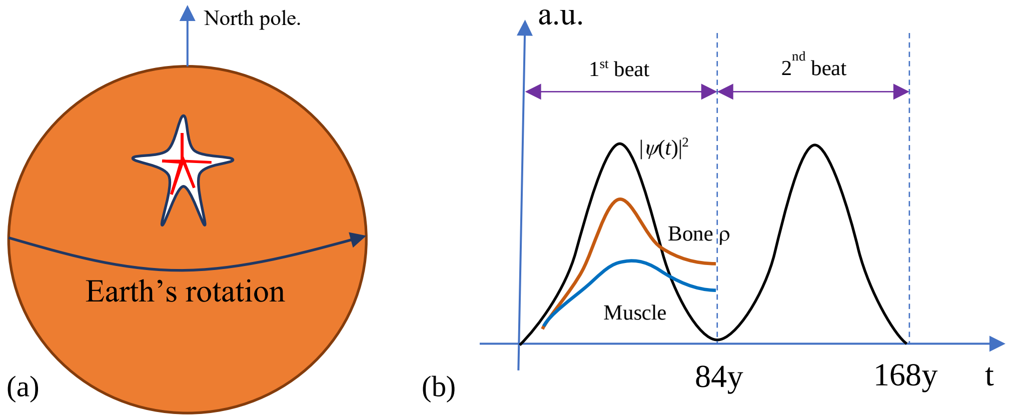

Fig.7 (a)A human sketch with the head pointing to the North Pole. (b) the biological gravity-clock.

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:

$$|\psi|^2 = |\psi_{blood} + C\psi_{shell}|^2 = 1 + C^2 + 2C\cos\left[\frac{2\pi}{\lambda_{beat}}\int_L dl - \frac{2\pi}{T_{beat}}t\right]$$
$$\frac{2\pi}{T_{beat}} = \simeq \frac{\beta}{c^3}\left(\frac{v_{blood}^{\ 2}}{2} - \frac{v_{shell}^{\ 2}}{2}\right);\quad \frac{2\pi}{\lambda_{beat}} = \frac{\beta}{c^3}(v_{blood} - v_{shell});\quad v_{shell} = \omega r \qquad (11)$$

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

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

```
<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.7(a), producing a positive beat and a negative beat in the two arms with the same period 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 preceding section 2, the beat $|\psi|^2$ is proportional to the matter density.

$$|\psi|^2 \propto \rho \quad (13)$$

The $|\psi|^2$ oscillation of the beat in Fig.7(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.7(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

$$\int_0^T \frac{F(C)dt}{T_{beat}(t)} = \int_0^T \frac{F(C)\beta\left(v_{blood}^{\;2} - v_{shell}^{\;2}\right)}{4\pi c^3} dt = 1 \quad (14)$$

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.

6. Confirmation of the lifespan formula in mammals and birds

In the quantum gravity theory, the interference between the earth’s rotating speed and human blood speed happens in statistical ensemble space, for instance, the first pulse and the second pulse from the heart has no detectable interaction in the realistic world, but in their statistical ensemble space the two events have an interaction which establishes the biological gravity-clock for human life. Sleep position, walking, running, sitting, etc. may make influences on the human biological gravity-clock in some extent, cannot stop the ticking of the human biological gravity-clock *in the ensemble space where quantum statistics governs all*, because the blood never stops as the life.

This situation allows the pulses of heart beats to emit from the heart to body terminals randomly, from fast to slow propagation, but their behavior is totally governed by energy conservation law and statistical quantum rules in statistical ensemble space. In other words, don't measure the biological gravity-clock in realistic world, must detect the biological gravity-clock in the statistical ensemble space.

The blood pulse motion from fast to slow propagation in human body makes a trouble of how to exactly calculate the blood mean speed, the typical 1m/s speed in blood vessels happens at artery under the shoulders with which these most important segments are protected from any harms, i.e. inaccessible as the consequence of biological evolution.

The pulses emit from the heart to the terminals (two palms, two feet, head top) in one period t, they simultaneously arrive the terminals, as illustrated in Fig.8, i.e., the wave of heart beats propagates in phase at the terminals. Thus, the topological speed of human blood is defined in terms of heart rate h by

$$v_t = \frac{R}{t} = \frac{R}{1/h}; \quad R = \frac{height + width}{4} \quad . \tag{15}$$

For example, an adult's R=0.86m, the heart rate h=70pluses/min=1.167pulses/s, then the adult's blood topological speed is 1.003m/s. Therefore, we suggest that the blood mean speed in biological clock formula should be replaced by the blood topological speed, thus the gravity-clock becomes a convenient and operative equation

$$T_{beat} \simeq \frac{4\pi c^3}{\beta[(v_{shell} + v_t)^2 - v_{shell}{}^2]} \simeq \frac{2\pi c^3}{\beta v_t v_{shell}} = \frac{2\pi c^3}{\beta R h v_{shell}} \quad . \tag{16}$$

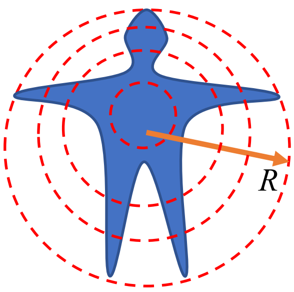

Fig.8 The pulses emit from the heart to the terminals in one period T, they simultaneously arrive the terminals.

It is well known for a long time that the ratio of heat loss to heat production increases as animal body size (topological radius R) is reduced; prevention of a fall in body temperature needs an increased heart rate. Thus, regarding human as a scale, the lifespan $T_{lifesapn}$ formula for mammals and birds is modified as

$$T_{lifespan} = \frac{R}{0.86} T_{beat} \simeq \frac{1}{0.86} \frac{2\pi c^3}{\beta h v_{shell}} \quad \Rightarrow \quad T_{lifespan} h = 3.08e+9(pulses) \quad . \tag{17}$$

Consequently, we arrive at a point where we should stay to check the validity of the new lifespan formula.

At the first, according to the new lifespan formula, the production of lifespan and heart rate holds a constant in mammals and birds. In 1997, H. J. Levine [15] reported that despite wide variations in body size and heart rate, the total number of heart beats/lifetime among mammals is remarkably constant, as shown in Fig.9, which confirms the above lifespan formula.

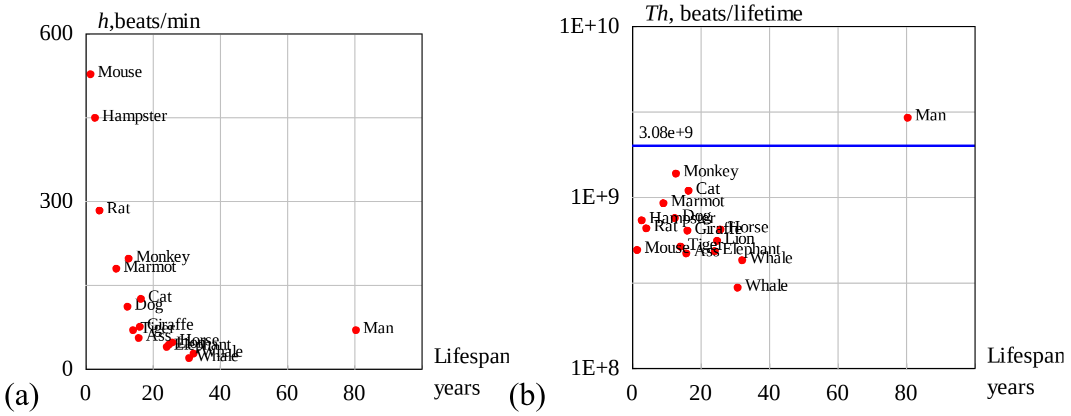

Fig.9 The relation between rest heart rate and life expectancy in mammals. Data source: H.J. Levine [15].

```
<Clet2020 Script>//Levine
char
str[50],str1[50],D[600]={"Man;80.70,1.83;Whale;31.14,1.25;Whale;32.46,1.39;Elephant;24.34,1.57;Lion;25.00,1.62;Horse;26.3
2,1.66;Ass;16.23,1.73;Tiger;14.47,1.82;Giraffe;16.45,1.86;Dog;12.94,2.04;Cat;16.67,2.09;Marmot;9.65,2.25;Monkey;13.16,2.29
;Rat;4.39,2.45;Hampster;3.07,2.65;Mouse;1.75,2.72;end;0,0;"};
double w,h,a,R,x,y,dP[10],S[10]; int i,j,k,m,nP[10];
main(){j=1; k=30;
SetAxis(X_AXIS,0,0,100,"Lifespan#nyears;0;20;40;60;80; ;");
if(j==0) SetAxis(Y_AXIS,0,0,600,"#ifh#t,beats/min;0;300;600;");
else if(j==1) SetAxis(Y_AXIS,8,8,10,"#ifTh#t, beats/lifetime;1E+8;1E+9;1E+10;");
DrawFrame(0x0154,1,0xafffaf);SetFont(SMALL,0,0,0); SetPen(2,0xff0000);
for(i=0;i<k;i+=1) {nP[0]=TAKE; nP[1]=i+i; TextJob(nP,D,str); nP[1]=i+i+1; TextJob(nP,D,str1);
nP[0]=14; m=TextJob(nP,str1,dP); a=dP[0]; h=dP[1]; h=pow(10,h); if(a<1) break;
S[0]=a; S[1]=h; if(j==1) {x=a*h*365*24*60; S[1]=log(x);}
Plot("OVALFILL,0,1,XY,3,3,",S); TextHang(S[0]+2,S[1],0,str);}
if(j==1) {SetPen(2,0xff);Polyline(2,"0,9.3,100,9.3,");TextHang(2,9.36,0,"3.08e+9");}
}}#v07=?>A
```

The one conspicuous exception to this observation is humans. One might speculate as to the reasons why, or more specifically how, modern humans have stretched the boundaries of biology to achieve a life expectancy of 84 years. Perhaps the most obvious explanations would credit advances in science, medicine and sociology.

Fig.10 shows another data source [16][17] that indicates that the total number of heart beats/lifetime among 34 species of mammals and birds is remarkably constant, which confirms the above lifespan formula.

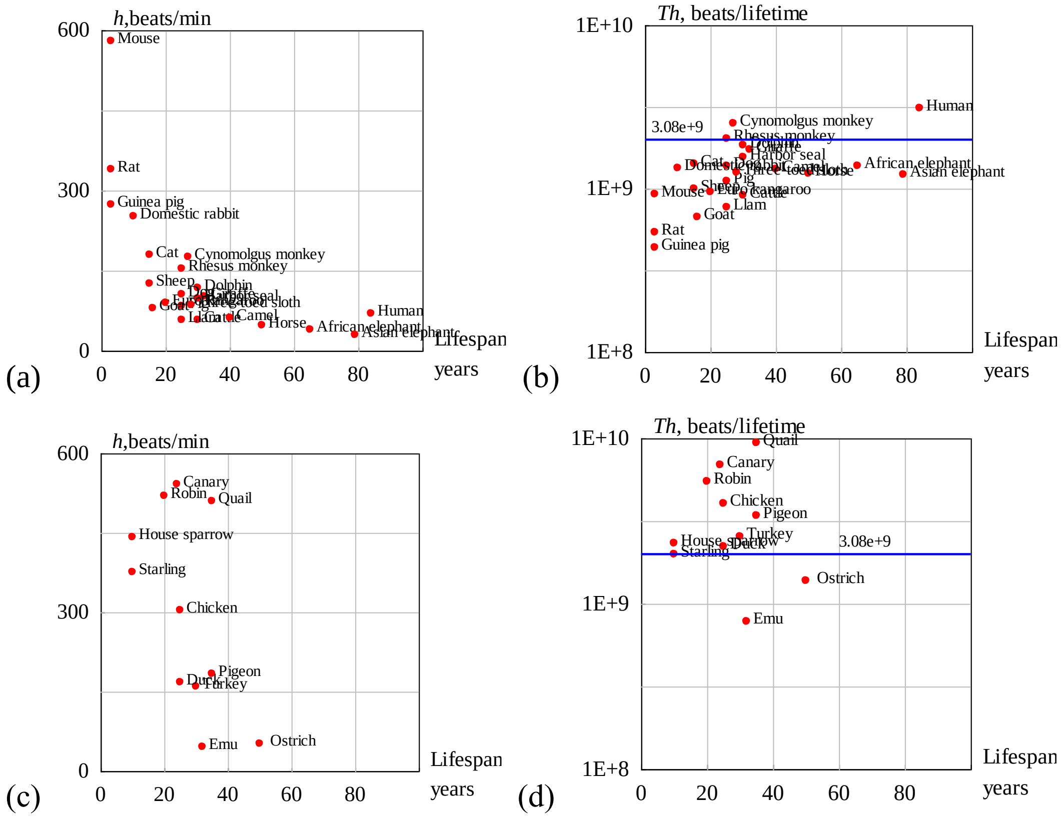

Fig.10 The relation between rest heart rate and life expectancy in mammals and birds. Data source: R.S. Seymour et al [16], Z.C. Lian et al [17].

```
<Clet2020 Script>//Mammal & Bird
char D[600]={"African elephant;4080,40,65;Asian
elephant;2860,29,79;Giraffe;651,102,32;Cattle;508,57,30;Horse;422,47,50;Camel;369,62,40;Llam;108,58,25;Pig;102,84,25;Dol
phin;93.1,117,30;Human;68.8,70,84;Harbor seal;60.3,98,30;Sheep;47.5,126,15;Goat;31.2,79,16;Euro
kangaroo;30.3,90,20;Dog;19.2,105,25;Cynomolgus monkey;4.6,175,27;Rhesus monkey;4.25,154,25;Three-toed
sloth;3.73,85,28;Cat;3.03,179,15;Domestic rabbit;2.51,251,10;Guinea
pig;0.52,273,3;Rat;0.34,340,3;Mouse;0.03,580,3;end;0,0,0;"};
//char D[600]={"
Ostrich;110,52,50;Emu;37.5,46,32;Turkey;4.77,160,30;Chicken;1.95,304,25;Duck;1.89,167,25;Pigeon;0.36,184,35;Quail;0.13,5
10,35;Robin;0.08,520,20;Starling;0.06,375,10;House sparrow;0.03,442,10;Canary;0.01,542,24;end;0,0,0;"};
double w,h,a,R,x,y,dP[10],S[10]; int i,j,k,m,nP[10];char str[50],str1[50];
main(){j=1; k=30;
SetAxis(X_AXIS,0,0,100,"Lifespan#nyears;0;20;40;60;80; ;");
if(j==0) SetAxis(Y_AXIS,0,0,600,"#ifh#t,beats/min;0;300;600;");
else if(j==1) SetAxis(Y_AXIS,8,8,10,"#ifTh#t, beats/lifetime;1E+8;1E+9;1E+10;");
DrawFrame(0x0154,1,0xafffaf);SetFont(SMALL,0,0,0); SetPen(2,0xff0000);
for(i=0;i<k;i+=1) {nP[0]=TAKE; nP[1]=i+i; TextJob(nP,D,str); nP[1]=i+i+1; TextJob(nP,D,str1);
nP[0]=14; m=TextJob(nP,str1,dP); w=dP[0]; h=dP[1]; a=dP[2]; if(a<1) break;
S[0]=a; S[1]=h; if(j==1) {x=a*h*365*24*60; S[1]=log(x);}
Plot("OVALFILL,0,1,XY,3,3,",S); TextHang(S[0]+2,S[1],0,str);}
if(j==1) {SetPen(2,0xff);Polyline(2,"0,9.3,100,9.3,");TextHang(2,9.36,0,"3.08e+9");}
}}#v07=?>A
```

Next, the body mass is proportional to the spherical volume of the body topological radius, this expression is given by

$$M_b \propto \rho \frac{4}{3} \pi R^3 \ . \qquad (18)$$

The heart rate expression is given by

$$h = \frac{v_t}{R}; \quad \Rightarrow \quad h \propto M_b^{-1/(3+a)} \ . \qquad (19)$$

where the exponent a denotes other unidentified factors. In 2011, T. H. Dawson [18] reported that heart rate should vary with body mass to the negative ¼-th power, as shown Fig.11. it illustrates the excellent agreement of heart-rate measurements with the above noted dependence with a=1, as has generally been known for many years. The new lifespan formula consists with this observation.

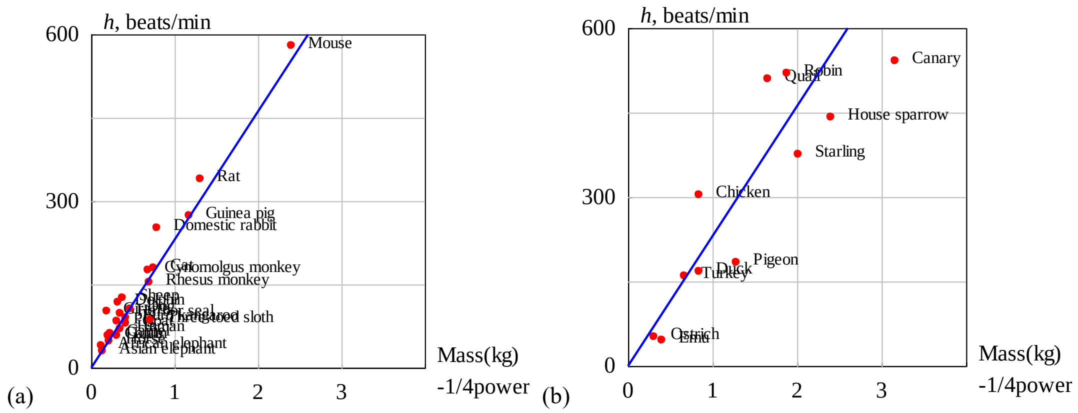

Fig.11 Data illustrating variation of resting heart rate with mammal and bird mass to the negative ¼-th power.

Data source: R.S. Seymour et al [16].

```
<Clet2020 Script>//Mammal & Bird
char D[600]={"African elephant;4080,40,65;Asian
elephant;2860,29,79;Giraffe;651,102,32;Cattle;508,57,30;Horse;422,47,50;Camel;369,62,40;Llam;108,58,25;Pig;102,84,25;Dol
phin;93.1,117,30;Human;68.8,70,84;Harbor seal;60.3,98,30;Sheep;47.5,126,15;Goat;31.2,79,16;Euro
kangaroo;30.3,90,20;Dog;19.2,105,25;Cynomolgus monkey;4.6,175,27;Rhesus monkey;4.25,154,25;Three-toed
sloth;3.73,85,28;Cat;3.03,179,15;Domestic rabbit;2.51,251,10;Guinea
pig;0.52,273,3;Rat;0.34,340,3;Mouse;0.03,580,3;end;0,0,0;"};
//char D[600]={"
Ostrich;110,52,50;Emu;37.5,46,32;Turkey;4.77,160,30;Chicken;1.95,304,25;Duck;1.89,167,25;Pigeon;0.36,184,35;Quail;0.13,5
10,35;Robin;0.08,520,20;Starling;0.06,375,10;House sparrow;0.03,442,10;Canary;0.01,542,24;end;0,0,0;"};
double w,h,a,R,x,y,dP[10],S[10]; int i,j,k,m,nP[10];char str[50],str1[50];
main(){k=30;
SetAxis(X_AXIS,0,0,4,"Mass(kg)#n-1/4power;0;1;2;3; ;");
SetAxis(Y_AXIS,0,0,600,"#ifh#t, beats/min;0;300;600;");
DrawFrame(0x0144,1,0xafffaf);SetFont(SMALL,0,0,0); SetPen(2,0xff0000);
for(i=0;i<k;i+=1) {nP[0]=TAKE; nP[1]=i+i; TextJob(nP,D,str); nP[1]=i+i+1; TextJob(nP,D,str1);
nP[0]=14; m=TextJob(nP,str1,dP); w=dP[0]; h=dP[1]; a=dP[2]; if(a<1) break;
S[0]=1/pow(w,0.25); S[1]=h;
Plot("OVALFILL,0,1,XY,3,3,",S); TextHang(S[0]+0.2,S[1],0,str);}
SetPen(2,0xff);Polyline(2,"0,0,2.6,600,");
}}#v07=?>A
```

7. Discussion

Theoretically, decrease in the blood mean speed in artery would extend human lifespan, there are many ways to do so such as medicines, herbs, calorie restriction and migration to other planets etc., but inappropriate practice may get in trouble with blood-pulse out phase. For instance, in an experiment, the digoxin-treated mice lived longer than control mice (50% survival of 850 vs. 700 days, p<0.001) and had slower heart rates (266 vs. 563 beats/min, p<0.001); however, the conclusion that prolongation of life in these mice was the consequence of a slower heart rate was seriously confounded by some other facts [15].

As illustrated in Fig.8, the blood pulses emit from the heart to the terminals in one period t, they simultaneously arrive the terminals (two palms, two feet, head top). This simultaneity is called as the terminal in phase, when blood speed holds at a stable value v_t=Rh, then any change in heart rate h needs a variation in the topological radius R, unfortunately adult's radius R is fixed: for baby the terminal out phase sends a signal to the body to grow; for old man the terminal out phase sends a signal to the body to ruin.

So, rude medicine and herb therapy for lifespan extension fill with uncertainty with probably wrong signals. Nevertheless, principle of the terminal in phase is applicable to organ transplant.

Migration to other planets faces many challenges such as adaptation to gravity and atmosphere [19] [20].

Caloric control is the most studied method of prolonging life, which has been studied in animals for decades. Calorie restriction with nutritional guarantees is probably the most effective means of longevity known.

One in daily life needs a normal calorie Q_0 per day, corresponding to a normal blood mean speed v_t in the artery; he or she may actually intake a calorie Q per day corresponding to a blood mean speed v in the artery, then the empirical expression is given by

$$\frac{v}{v_t} = \sqrt{\frac{Q}{Q_0}} \quad . \tag{20}$$

For the convenience of food estimation, a **longevity index** of food is defined as

$$L = T_0 \sqrt{\frac{Q_0}{Q}}; \quad T_0 = 84(years) \quad . \tag{21}$$

A normal person should have a total calorie intake of 2000 calories per day, and those who exercise can increase it appropriately. The various ingredients and their calories list as followings: 9 calories per gram of fat, 4 calories per gram of carbohydrates, and 4 calories per gram of protein.

With this longevity index guidance, calorie restriction with nutritional guarantees becomes an operative and effective method for longevity.

8. Conclusions

Rather than biological time being controlled solely by a molecular cascade domino effect, this paper suggests that the gravity-clock of planetary-scale relativistic matter wave acts to regulate lifespan. It is found that the 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. According to the gravity-clock concept, the period of sunspot cycle is calculated to be 10.95 years, the human lifespan on the Earth is calculated to be 84 years. The lifespan model is applicable to a variety of animals, it predicts that the total number of heart beats/lifetime among mammals and birds is remarkably constant: 3e+9 (beats/lifetime), the conclusion has been confirmed by the observations of 34 species of mammals and birds.

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