High precise Newtonian constant of gravitation with correlation of Earth rotation and Solar mass

JianFei Chen

Nov.16, 2019

[Abstract]

This paper showed that there is a strict logical relationship between the energy wave of mean solar day and the energy wave of the solar mass. With this relationship, calculated the precise value of the solar mass. And with the earth orbit, calculated the precise value of Newtonian constant of gravitation. G=6.672 148 4714(274) × 10^{-11} m^3/kg s^2, its relative uncertainty is 4.0×10^{-9}. This paper avoided that complex laboratory environment affects the weak force of universal gravitation, and raised the relative uncertainty of G to high precision as other constants.

Usage: Quantum physics, string theory, astrophysics

keywords: universal gravitation, Solar mass, Earth rotation, oscillation.

Universal Gravitation is a long-range force which is useful in astrophysics. Newtonian constant of gravitation is important for astrophysics, which was usually measured in the laboratory. But Universal Gravitation is too small, the complex environment in the laboratory seriously affects the accuracy of experiment, relative uncertainty of which only reach 10-4 or 10-5. Calculating with planet orbit will be an effective way to get high precise value of G.

Authors found that solar mass is impacting the Earth rotation and main solar activity, which are 5-minute oscillation, 160-minute oscillation, 11.2-year sunspot cycle. Their relations are $11.2\text{year} \approx 2^{12}\text{day}$ and $1\text{day} = 160\text{min} \times 9 = 5\text{min} \times 2^5 \times 9$.

Astronomical measurements showed that Earth rotation is most stable. At the view of sun impacting, solar day is more close to the Sun than sidereal day of Earth. What is the relation of mean solar day and sun?

The solar mass can be found in the internet as follow.

$$M_{\odot} = 1.9891 \times 10^{30}\ kg \tag{1}$$

With Mass energy equation and Plank's quantum formula, can get

$$E = M_{\odot}c^2 = hc/\lambda_{M_{\odot}} \Longrightarrow \lambda_{M_{\odot}} = h/M_{\odot}c \tag{2}$$

With h and c in CODATA: 2018[1] and equation (1, 2), then get

$$c = 299\ 792\ 458\ m/s \tag{3}$$

$$h = 6.626\ 070\ 15 \times 10^{-34}\ J\ s \tag{4}$$

$$\lambda_{M_{\odot}} = h/M_{\odot}\, c = 1.111165 \times 10^{-72}\ m \tag{5}$$

Mean solar day is as follows.

$$T_0 = 24 \times 3600 = 86400\ s$$

$$\lambda_0 = c\, T_0 = 2.590207 \times 10^{13}\ m \tag{6}$$

Compare λ_0 and $\lambda_{M_{\odot}}$, get as follows.

$$\lambda_0/\lambda_{M_{\odot}} = 2.331073 \times 10^{85} = (1 - 56ppm) \times 12 \times 2^{280} \tag{7}$$

According to Method (#3) of Equivalent principle of 2n resonance, $2^{280} \overset{\text{energy}}{\Longleftrightarrow} 1$. According to Method (#2) of preferred resonance principle of 12 times wavelength, 12 is the times of preferred resonance. According to Method (#1) of integer ratio principle of two interrelate waves, with resonating of λ_0 and $\lambda_{M_{\odot}}$, the little difference of 56ppm will disappear, and $\lambda_0/\lambda_{M_{\odot}}$ is a strict integer ratio of 12×2^{280} in fact. With equation (7, 6, 2), thus

$$\frac{\lambda_0}{\lambda_{M_{\odot}}} = \frac{c\, T_0}{\lambda_{M_{\odot}}} = \frac{M_{\odot}c^2 T_0}{h} = 12 \times 2^{280} \tag{8}$$

$$M_{\odot} = 3 \times 2^{282} h/c^2 T_0 \tag{9}$$

Therefore, with equation (9), we can calculate the precise value of solar mass with precise value of mean solar day.

Now the atomic clock with excellent stability is used for timing, but there is little fluctuation of mean solar day. We can calculate the precise mean solar day with the data of IERS [2] as follows: (To ensure the consistency, every data is of 2000.)

1999. Jul.1: UT1-TAI=-31.4801s

2000. Jul.1: UT1-TAI=-31.7959s

Uncertainty is smaller than 0.0002s

With above data, calculate the average value of mean solar day on Jan 1, 2000.

$$\Delta\, T(a\ year) = \Delta\, (UT1 - TAI) = -0.3158\ s$$

$$T_0 = 86400 + 0.3158/365.2422 = 86400.0008646317\ s \tag{10}$$

Relative uncertainty is 1.27×10^{-11}

With equation (9, 10, 3, 4), the value of solar mass as follows.

$$M_{\odot} = 3 \times 2^{282} h/c^2 T_0 = 1.9892112591 \times 10^{30}\ kg \tag{11}$$

Relative uncertainty is 1.27×10^{-11}

With the precise value of solar mass and orbit of Earth revolution, we can calculate the value of Newtonian constant of gravitation as follows.

$$F = \frac{GM_{\odot}m}{r^2} = \frac{mv^2}{r} = \frac{m}{r}\frac{4\pi^2 r^2}{T^2} \Longrightarrow G = \frac{4\pi^2 r^3}{M_{\odot}T^2} \tag{12}$$

The orbit radius r of Earth revolution is of DE405: AUEPM2000

$$r = 149\ 597\ 870\ 691.2 \pm 0.2\ m \tag{13}$$

Relative uncertainty is 1.34×10^{-12}

#1. When mean sidereal year is used as the period of Earth revolution T, the value for the J2000.0 epoch of IERS 2014 is as follows.

$$T = 365.256\ 363\ 004\ Ephemeris\ days = 31\ 558\ 149.763\ 5456\ s \tag{14}$$

To the other value 365d 6h 9m 9.54s, the relative uncertainty is 7.08×10^{-9}

With equation (12, 11, 13, 14), thus

$$G_1 = 4\pi^2 r^3/M_{\odot}T^2 = 6.671\ 630\ 6988 \times 10^{-11}\ m^3/kg\ s^2 \tag{15}$$

Relative uncertainty is 1.4×10^{-8}

#2. When using mean tropical year as the period of Earth revolution T, the value for the J2000.0 epoch of IERS 2014 is as follows.

$$T = 365.242\ 190\ 402\ SI\ days = 31\ 556\ 925.250\ 7328\ s \tag{16}$$

To the old value 365.242 189 670 SI days, the relative uncertainty is 2.00×10^{-9}

With equation (12, 11, 13, 16), thus

$$G_2 = 4\pi^2 r^3/M_{\odot}T^2 = 6.672\ 148\ 4714 \times 10^{-11}\ m^3/kg\ s^2 \tag{17}$$

Relative uncertainty is 4.0×10^{-9}

[Discussion] While Earth is moving around the Sun, the effects from Sun to Earth includes Universal Gravitation and sunlight. The two effects should be synchronous. The effect of sunlight to Earth is synchronous with tropical year. It means there are some relations between Universal Gravitation and tropical year. The sidereal year match the effect of outside universe. So tropical year is more synchronous with the effect from Sun than sidereal year. At the view of the effect of Sun, mean tropical year is the real revolution period, not the sidereal year, while mean solar day is the real rotation period of Earth, not the sidereal day. And to the measure data, G_2 is closer than G_1. Therefore it is reasonable to calculate Newtonian constant of gravitation with mean tropical year. This data is close to the measured data of [6.672 48(43) × 10^{-11} $m^3/kg\ s^2$] [4] and [6.672 34(14) × 10^{-11} $m^3/kg\ s^2$] [5] and [6.672 22(87) × 10^{-11} $m^3/kg\ s^2$] [6] [7]

[Summary] The correlation between Earth rotation and solar mass determines the exact value of solar mass. Comparing tropical year and sidereal year with the effect from Sun to Earth, determines that mean tropical year is the real period of Earth revolution. Finally gets the precise value of Newtonian constant of gravitation. G=6.672 148 4714(274) × 10^{-11} $m^3/kg\ s^2$, its relative uncertainty is 4.0×10^{-9}. This paper avoids the interference from the complex laboratory environment to the weak force of universal gravitation, and raise the value of G to high precision.

Methods

#1. Integer ratio principle of two interrelate waves:

Two waves always interrelate with a strict ratio of their frequency (wavelength) as the ratio of two integers. This is clearly reflected in quantum Hall theory and fractional quantum Hall theory.

#2. Preferred resonance principle of 12 times wavelength:

According to paper "Logic about forming hydrogen atom from Higgs Bosons[3]", at the beginning of the evolution of matter, 12 times of particles always gather into a new particle one by one, it means a particle includes 12 same parts. This structure will remain at any time. So any energy wave always prefers the resonant wave with 12 times of its wavelength.

#3. Equivalent principle of 2n resonance:

According to paper "Logic about forming hydrogen atom from Higgs Bosons [3]", the resonance of double or half frequency can occur indefinitely one by one with energy transferring, until the energy is absorbed. $\lambda \overset{\text{energy}}{\Longleftrightarrow} 2^n\lambda$

Acknowledgements

Thanks to NIST and CODATA and IERS for providing the data, which were important for this paper. Scientific research need many data, which cannot be measured precise by a person or an organization. So sharing data is very important to every research.

References

1. NIST, CODATA Internationally recommended 2018 values of the Fundamental Physical Constants, https://physics.nist.gov/cuu/Constants/index.html, 2019.
2. Wolfgang R. Dick and Bernd Richter, IERS Annual Report 2000, p. 58, 2001
3. JianFei Chen, Logic about forming hydrogen atom from Higgs Bosons, p. 3 and p.1, E-print, 2019
4. G. G. Luther and W. R. Towler. Redetermination of the Newtonian gravitational constant. Physical Review Letters, 48:121, 1982.
5. Harold V. Parks and James E. Faller, Simple Pendulum Determination of the Gravitational Constant, PRL 105, 110801, Sep 2010
6. Z.-K. Hu, J.-Q. Guo, and J. Luo. Correction of source mass effects in the HUST-99 measurement of G. Physical Review D, 71:127505, June 2005.
7. J. Luo, Z.-K. Hu, X.-H. Fu, S.-H. Fan, and M.-X. Tang. Determination of the Newtonian gravitational constant G with a nonlinear fitting method. Physical Review D, 59:042001, December 1998.