General introduction for posters 623, 624, 625, 626, 627. There are two classes of the quantum gravitational effects in the gravitation of big bodies.

The first class consists of the quantum gravitational effects which are determined by the quantum gravitational constant H = 145.5 km/s and the sequences of $1/n(n + 1)$, $1/n^2$, n^2, $n(n + 1)$.

The second class consists of the quantum gravitational effects which are determined by the sequence of n and different quantization steps for the different parameters of single and double stars. Each of the latter consists of two very close stars.

The quantum gravitational effects of the first and second classes are investigated in posters 623 and 624, 625, 626, 627, respectively.

623
Quantum gravitational effects in rotation and size of big bodies

S V Synitsyn
s.sinitsyn@mail.ru

Part 1. General form of wave equation of a planet.

The first step. Let's write down the time-independent Schrödinger wave equation for any planet of any planetary system and Newton gravitation

$$-(h/2\pi)^2\Delta\psi/2m - (GMm/r)\psi = E\psi,$$

where ψ is the wave function of a planet with mass m and the energy of E. Moreover, r is the distance of the planet to its star with mass M. It is accepted that $M >> m$, which is true for any planetary system.

The second step. Let's divide the left and right sides of the Schrödinger equation by m

$$-(h/2\pi m)^2\Delta\psi/2 - (GM/r)\psi = \varepsilon\psi,$$

where $\varepsilon = E/m$ is the specific energy of the planet.

Why should we do it? Planets have the masses of the different orders of magnitude. For example, the mass difference between Mercury and Jupiter is four orders of magnitude. Therefore, the energy per unit planet mass should be quantized.

The third step. Let's make the transition from the coordinates (x, y, z) to the reduced coordinates $(x' = x/GM, y' = y/GM, z' = z/GM)$

$$-(h/2\pi GMm)^2\Delta'\psi/2 - (1/r')\psi = \varepsilon\psi,$$

where $r' = r/GM$.

Why should we do it? The sought wave equation must be obtained in general form.

The fourth step.

Then let's make transition from $h/2\pi GMm$ to $1/H$ where H is the quantum gravitational constant.

Why should we do it? The Planck constant should be replaced by the constant H.

As a result, the general form of the time-independent wave equation for any planet of any planetary system is

$$-\Delta'\psi/2H^2 - (1/r')\psi = \varepsilon\psi \qquad (1)$$

From this general form

$$\varepsilon_n = -H^2/2n^2,\ r_n/GM = n^2/H^2 \qquad (2)$$

Part 2. Quantum gravitational constant *H*.

The quantum gravitational constant should be determined from the structure of the Solar System.

Why should we do it? The parameters of the solar planet orbits are determined with high accuracy.

The first step. The eccentricities of the solar planet orbits are close to zero (~ 0.001 – 0.01) with the exception of Mercury. Hence, for such planets, the semi-major axis of orbit a is determined by the solution of (1).

The second step. Let's establish that in any planetary system energy levels can be filled inconsistently and not from the first level.

The third step: Let's suggested that the nearest terrestrial planets consistently occupy neighboring energy levels.

Why should we do it? According table 1 for the nearest terrestrial planets the difference between a is the order of magnitude less than the nearest giant planets.

Using these steps and the least squares method, it is obtained that H is 145.5 km/s.

According table 1 the average difference between the calculated and empirical values of a is 3% with the maximum value of 7% for Venus. According table 1 equations (1, 2) are valid when $Gm/n^2 \geq 1190$ km^3/s^2. For the moon, Gm/n^2 is only 0.24 km^3/s^2.

Table 1. The parameters of solar planets [1] and the calculated results for these planets.

Planet	Gm, 10^3 km^3/s^2	a, a.u.	n	r_n, a.u.	$\Delta r/a$,[1] %	$\Delta r/\Delta r_\pm$,[2] %	Gm/n^2, 10^3 km^3/s^2
Mercury	22.03	0.387	3	0.377	- 2.6	3	3
Venus	324.9	0.723	4	0.670	- 7.3	14	20.3
Earth	398.6	1.000	5	1.048	4.8	13	15.9
Mars	42.83	1.524	6	1.508	- 1.0	3	1.19
Jupiter	126700	5.203	11	5.070	- 2.6	14	1050
Saturn	37930	9.537	15	9.428	- 1.1	8	169
Uranus	5794	19.19	21	18.48	- 3.7	39	13.1
Neptune	6835	30.07	27	30.55	1.6	22	9.38
Pluto	0.8261	39.48	31	40.27	2.0	31	0.0009

1) $\Delta r = r_n - a$;

2) if $\Delta r < 0$, $\Delta r_\pm = r_n - r_{n-1}$, if $\Delta r > 0$, $\Delta r_\pm = r_{n+1} - r_n$;

Part 3. Quantum hard rotator.

From (1) for the quantum hard rotator

$$-\Delta'\psi/2H^2 = \varepsilon\psi,$$

From this equation

$$V_n^2 = n(n+1)H^2,\ n = 1, 2, \ldots$$

Figure 1 shows the distribution of the detached double-lined eclipsing systems (DDLESes). Each DDLES consists of two very close stars, which are the first and second components. The coordinate axis is the second power of the relative orbital velocity of the first and second components (V^2). The distribution is constructed, using empirical data [2].

Two peaks are visible about the quantum values of H^2 and $2H^2$. Hence

$$V_n^2 = n^2H^2,\ n = 1, 2, \ldots$$

Thus, DDLESes rotate like the quantum hard rotator.

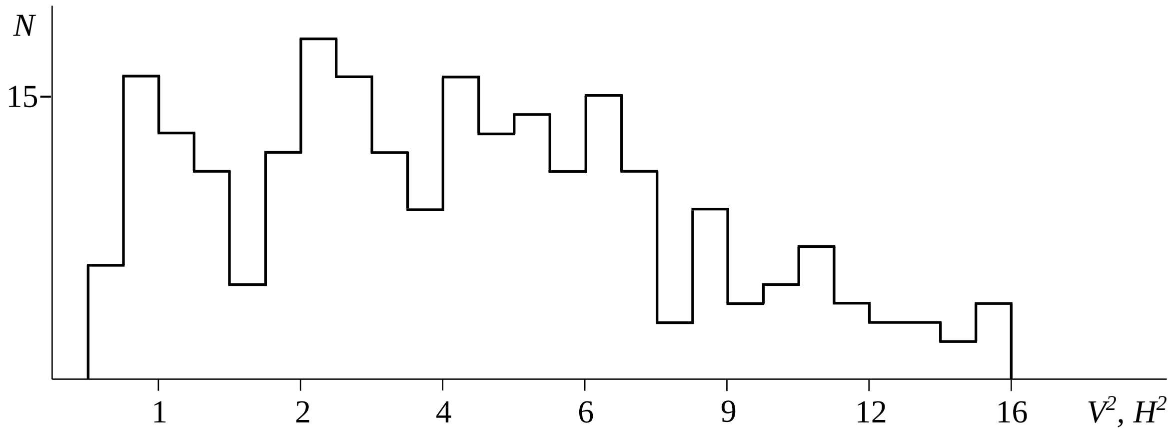

Figure1. The distribution of 254 detached double-lined eclipsing systems.

Figure 2 shows the distribution of the spiral galaxies. The coordinate axis is the second power of the "plateau" orbital velocity of spiral galaxy stars (V_∞^2). The distribution is constructed, using empirical data [3].

Three peaks are visible about the quantum values of $H^2/2$, H^2 and $2H^2$. Empirical data [4] and [5 – 8], respectively, for 304 and 536 other spiral galaxies confirm the validity of this distribution. Note that the galaxies of samples [3], [4] and [5 – 8] are located in different parts of the sky. According to [9, 10] for 2967 spiral galaxies there are peaks about the quantum values of $H^2/9$, $H^2/4$, $H^2/2$ and H^2. Hence

$$V_n^2 = H^2/n(n + 1),\ H^2/n^2,\ n = 1, 2, \ldots$$

Thus, spiral galaxies rotate also like the quantum hard rotator.

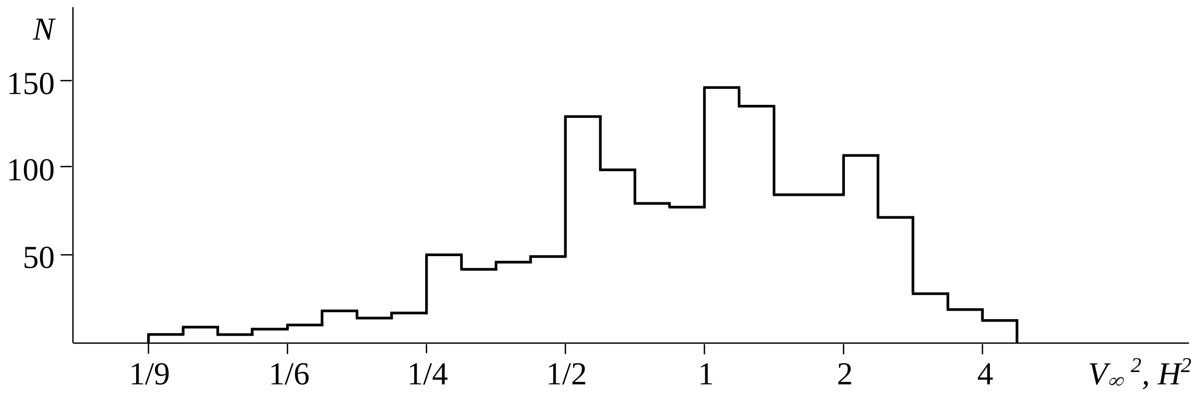

Figure 2. The distribution of 1355 spiral galaxies.

Part 4. Size of big body.

For Jupiter and the Sun, their reduced radius R/GM is the quantum value of $12/H^2$ and $1/9H^2$ with the error of 0.4% and 0.08%, respectively. These results follow from empirical data [1].

In this regard, it is proposed that if the mass of any big body increases the latter is compressed so that R/GM decreases stepwise, taking quantum values

$$R/GM = 1/g_n H^2,\ g_n = n(n + 1),\ n^2,\ 1/n^2,\ 1/n(n + 1);\ n = 1, 2, \ldots \qquad (3)$$

The lower boundary of the validity of (3) is determined by Jupiter and Saturn.

For stars, the validity of (3) depends on the energy release of star nucleosynthesis.

The existence of (3) in explicit form is found for stars less than 1.55 solar masses. There is a decrease in the energy release of star nucleosynthesis.

The existence of (3) in more explicit form is found for stars more than 14.10 solar masses. There are qualitative and quantitative changes in the self-gravitation of the supermassive star.

Figure 3 shows the distribution of the single evolving supermassive stars. The coordinate axis is the reduced surface gravitational potential. The distribution is constructed, using empirical data [11, 12].

Two peaks are visible at the quantum values. The peaks are created by the populated areas of the temporal slowdown of the absolute evolutionary expansion of the supermassive star.

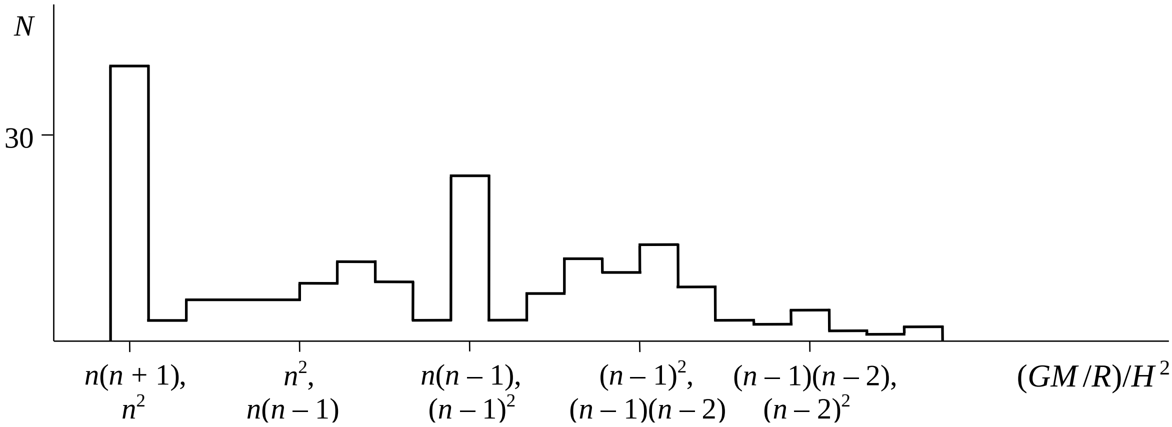

Figure 3. The distribution of 187 single evolving supermassive stars.

References

[1] *Solar system dynamics, http: //ssd.jpl.nasa.gov.*

[2] Pourbaix D *The ninth catalogue of spectroscopic binary orbits, http: //sb9.astro.ulb.ac.be*

[3] Mathewson D S, Ford F L and Buchhorn M 1992 *Astrophys. J. Suppl. Ser.* **81** 413

[5] Dale D A, Giovanelli R, Haynes M P, Scodeggio M, Hardy E and Campusano L E 1997 *Astron. J.* **114** 455

[6] Dale D A, Giovanelli R, Haynes M P, Scodeggio M, Hardy E and Campusano L E 1998 *Astron. J.* **115** 417

[7] Dale D A, Giovanelli R, Haynes M P, Hardy E and Campusano L E 1999 *Astron. J.* **118** 1468

[8] Dale D A and Uson J M 2000 *Astron. J.* **120** 552

[9] Roscoe D F 1999 *Astron. Asrophys.* **343** 697

[10] Roscoe D F 2002 *Astron. Asrophys.* **385** 431

[11] Massey P, Degioia-Eastwood K and Waterhouse E 2001 *Astron. J.* **121** 1050

[12] Humphreys R M 1978 *Astrophys. J. Suppl. Ser.* **38** 309

624

Quantum gravitational effects in formation of detached double-lined eclipsing systems (DDLESes)

S V Sinitsyn
s.sinitsyn@mail.ru

Introduction. The DDLES is consists of two very close stars which are the first and second components. The distance between these components is on the order of 1 or 10 solar radii. Indexes 1 and 2 indicate the first and second components, respectively.

If a quantum gravitational effect is carried out along the coordinate axis of the ratio of the values of any parameter of the first and second components, then it is of the second or third type.

The distributions of the DDLESes are constructed using empirical data from catalogs [1 - 4].

The quantum gravitational effect of the second type is found along the coordinate axis M_1/M_2.

Therefore, this effect is found in the formation of the first and second components.

Figure 1 shows the distribution of the DDLESes, the components of which have masses from 0.445 to 13.82 solar masses.

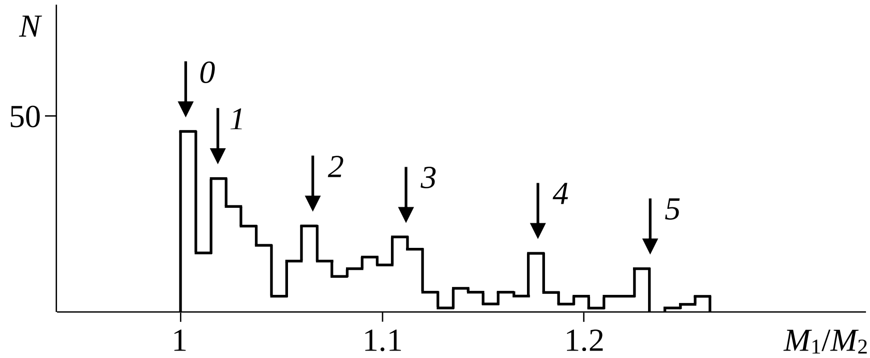

Figure 1. The distribution of 375 detached double-lined eclipsing systems.

Six peaks are visible, the positions of which are determined as

$M_1/M_2 = 0.0155n + 1.0187$, $n = -1, 0, 3, 6, 10, 14$

The quantum gravitational effect of the third type is found along the same coordinate axis about $M_1/M_2 = 1.0187$. Figure 2 shows the distribution of the DDLESes.

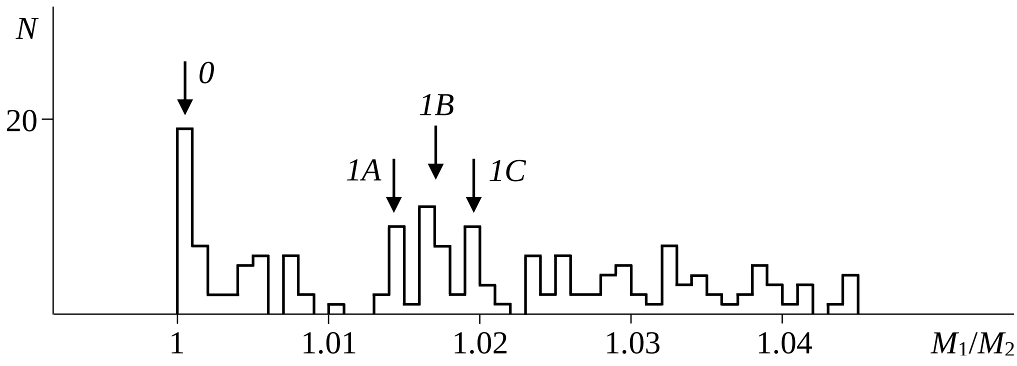

Figure 2. The distribution of 161 detached double-lined eclipsing systems.

At $M_1/M_2 = 1.0169 \pm 0.0005$ the symmetric separation of the populated area into three such areas (peaks *1A*, *1B*, *1C*) is visible.

Conclusion:

The found effects are due to these facts:

1. The peaks are created by the populated areas of the coordinated formation of the first and second components.
2. The formation of the first and second components is coordinated.
3. There is some quantum physical system which creates the coordinated formation of the first and second components. Moreover, this system is also the measuring instrument of the gravitational masses of these components.
4. This quantum physical system exists already before the formation of component bodies from baryonic matter.
5. A general gravitational mass of the DDLES is proposed as the quantum physical system.
6. The formation of the DDLES begins with the formation of own general gravitational mass. Then the latter begins to capture the gravitational masses of atoms. Moreover, it captures not any, but an agreed amount of them, while coordinating the formation of the bodies of the first and second DDLES components from baryonic matter.

References

[1] Malkov O Yu 2007 *Mon. Not. R. Astron. Soc.* **382** 1073

[2] Torres G, Andersen J and Giménez A 2010 *Astron. Astrophys. Rev.* **18** 67

[3] Eker Z, Bilir S, Soydugan F, Yaz Gökçe E, Soydugan E, Tüysüz M, Şenyüz T and Demircan O 2014 *Publ. Astron. Soc. Australia* **31** 24E

[4] Eker Z, Soydugan F, Soydugan E, Bilir S, Yaz Gökçe E, Steer I, Tüysüz M, Şenyüz T and Demircan O 2015 *Astron. J.* **149** 131

625
Quantum gravitational effects in evolutionary expansion of components of detached double-lined eclipsing systems (DDLESes)

S. V. Sinitsyn
s.sinitsyn@mail.ru

Introduction. The DDLES is consists of two very close stars which are the first and second components. Indexes 1 and 2 indicate the first and second components, respectively. M and R are the mass and radius of the component, respectively, H is the quantum gravitational constant which is 145.5 km/s. In addition $g = GM/R^2$ and is determined in cm/s^2, as it is assumed in astrophysics.

If a quantum gravitational effect is carried out along the coordinate axis:

of the value of any parameter of component, then it is of the first type;

of the ratio of the values of any parameter of the first and second components, then it is of the second or third type.

The distributions of DDLESes and its components are constructed using empirical data [1 - 4].

The quantum gravitational effects of the first type are found along the coordinate axes $(GM/R)/H^2$ and log(g). Figure 1 shows the distribution of components with masses from 1.55 to 2.77 solar masses.

Five peaks are visible, the positions of which are determined as

$(GM/R)/H^2 = 1.177n + 5.601$, $n = 0 – 4$

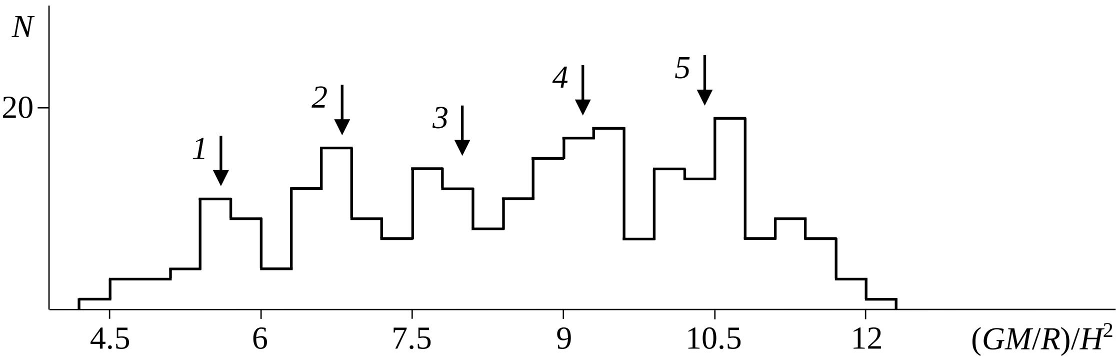

Figure 1. The distribution of 255 components of the detached double-lined eclipsing systems.

Figure 2 shows the distribution of the second components with masses from 2.77 to 8.60 solar masses.

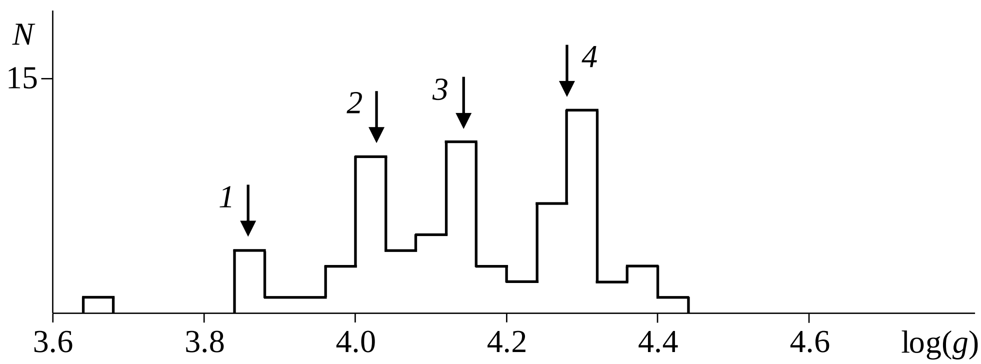

Figure 2. The distribution of 71 components of the detached double-lined eclipsing systems.

Four peaks are visible, the positions of which are determined as

$\log(g) = 0.069n + 3.663$, $n = 3, 5, 7, 9$

Conclusion:

The found effects are due to these facts:

1. In figures 1 and 2 the peaks are created by the populated areas of the temporal slowdown of the absolute evolutionary expansion of the component.
2. The absolute evolutionary expansion of the component is, in particular:
   its transitions along the coordinate axes $(GM/R)/H^2$ and $\log(g)$ between these areas and
   its temporal localization in the latter.
3. There is some quantum physical system which creates the quantum stepwise absolute evolutionary expansion of the component.
4. The gravitational mass of the component is proposed as the quantum physical system. This gravitational mass is also the measuring instrument of the size and gravitational parameters of the component.

The quantum gravitational effect of the second type is found along the coordinate axis $\log(g_1/g_2)$. Figure 3 shows the distribution of the DDLESes along this axis.

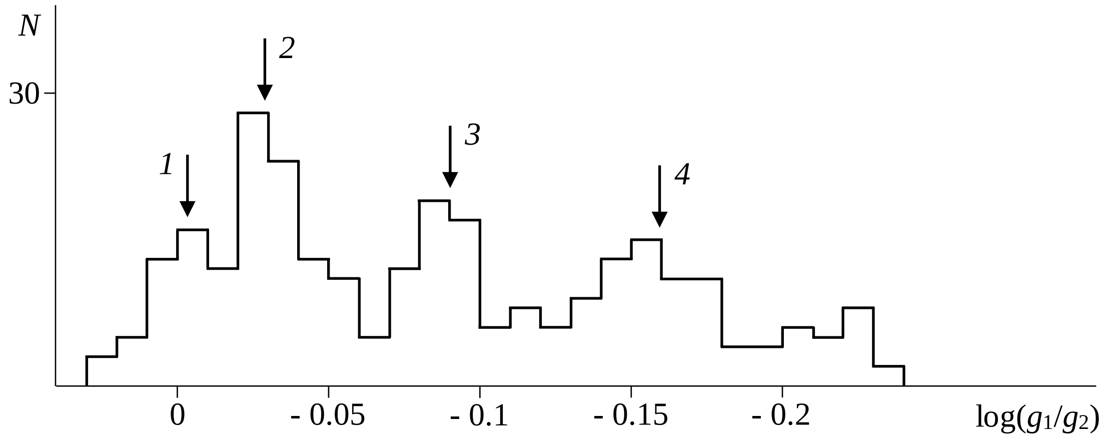

Figure 3. The distribution of 283 detached double-lined eclipsing systems.

Four peaks are visible, the positions of which are determined as

$$\log(g_1/g_2) = -\,0.0305n - 0.0004,\ n = 0, 1, 3, 5 \qquad (1)$$

The quantum gravitational effects of the second type are also found along the coordinate axes $\log(R_1/R_2)$, $\log((GM/R)_1/(GM/R)_2)$.

The quantum gravitational effect of the third type is found along the coordinate axis $(GM/R)_1/(GM/R)_2$ in the relative evolutionary expansion of the first and second components with a mass of less than 1.55 solar masses.

Figure 4 shows the distribution of such DDLESes about $(GM/R)_1/(GM/R)_2 = 1$.

At $n = 0$ and $(GM/R)_1/(GM/R)_2 = 1$ the symmetric separation of the populated area into three such areas (peaks *1A*, *1B*, *1C*) is visible. The quantization step is (0.017 ± 0.002). The same effect is found along coordinate axis $((GM/R)_1/H^2 - (GM/R)_2/H^2)$ near 0 with the quantization step equal to (0.16 ± 0.02).

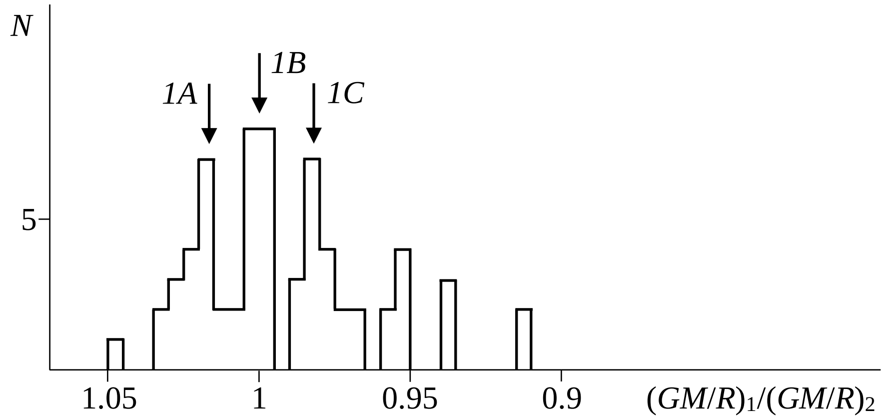

Figure 4. The distribution of 66 detached double-lined eclipsing systems.

Conclusion:

The found effects are due to these facts:

1. In figures 3 and 4 the peaks are created by the populated areas of the temporal coordinated relative evolutionary expansion of the first and second components.
2. The relative evolutionary expansion of the first and second components is, in particular: their transitions along three coordinate axes $\log(R_1/R_2)$, $\log((GM/R)_1/(GM/R)_2)$ and $\log(g_1/g_2)$ between these areas and their temporary localization in the latter.
3. There is some quantum physical system which creates the quantum stepwise relative evolutionary expansion of the first and second components.
4. A general gravitational mass of the DDLES is proposed as the quantum physical system. This gravitational mass is also the measuring instrument of the size and gravitational parameters of the first and second components.

References

[1] Malkov O Yu 2007 *Mon. Not. R. Astron. Soc.* **382** 1073

[2] Torres G, Andersen J and Giménez A 2010 *Astron. Astrophys. Rev.* **18** 67

[3] Eker Z, Bilir S, Soydugan F, Yaz Gökçe E, Soydugan E, Tüysüz M, Şenyüz T and Demircan O 2014 *Publ. Astron. Soc. Australia* **31** 24E

[4] Eker Z, Soydugan F, Soydugan E, Bilir S, Yaz Gökçe E, Steer I, Tüysüz M, Şenyüz T and Demircan O 2015 *Astron. J.* **149** 131

626

Gravitational scale factor and quantum gravitational effects in relative evolutionary expansion of components of detached double-lined eclipsing systems (DDLESes)

S. V. Sinitsyn
s.sinitsyn@mail.ru

Introduction. The DDLES is consists of two very close stars which are the first and second components. Indexes 1 and 2 indicate the first and second components, respectively. M and R are the mass and radius of the component, respectively, H is the quantum gravitational constant which is 145.5 km/s. In addition $g = GM/R^2$ and is determined in cm/s^2, as it is assumed in astrophysics.

If a quantum gravitational effect is carried out along the coordinate axis of the ratio of the values of any parameter of the first and second components, then it is of the second type. The distributions of the DDLESes and its components are constructed using empirical data from catalogs [1 - 4].

Part. 1. Gravitational scale factor. Figure 1 shows the distribution of the DDLES components. For groups of the components of different ages, isochrones are indicated by the dotted lines.

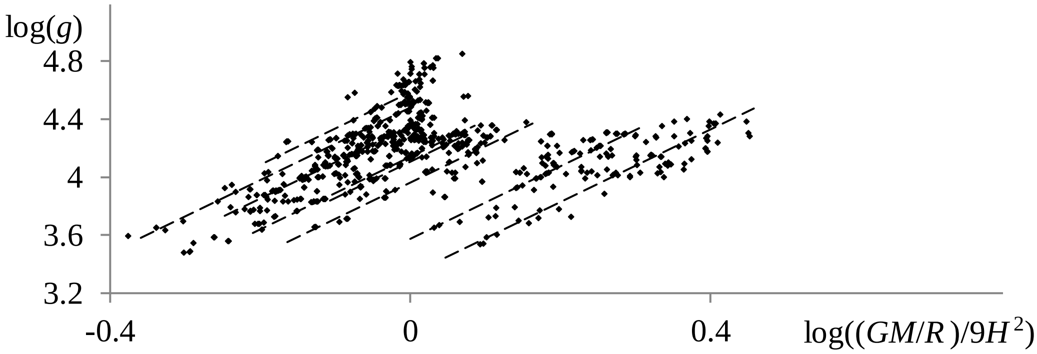

Figure 1. The distribution of 864 components of the detached double-lined eclipsing systems.

For each of the isochrones

$\log g = (5/2)\log((GM/R)/9H^2) + b$,

where b is some time parameter. It corresponds to $R \propto M^3$ for the DDLES component.

Figure 2 shows the distribution of the DDLESes. The first (■), second (◇), third (◆) groups, the common stars of these groups (○), as well as the fourth (△) and fifth (▲) groups are highlighted.

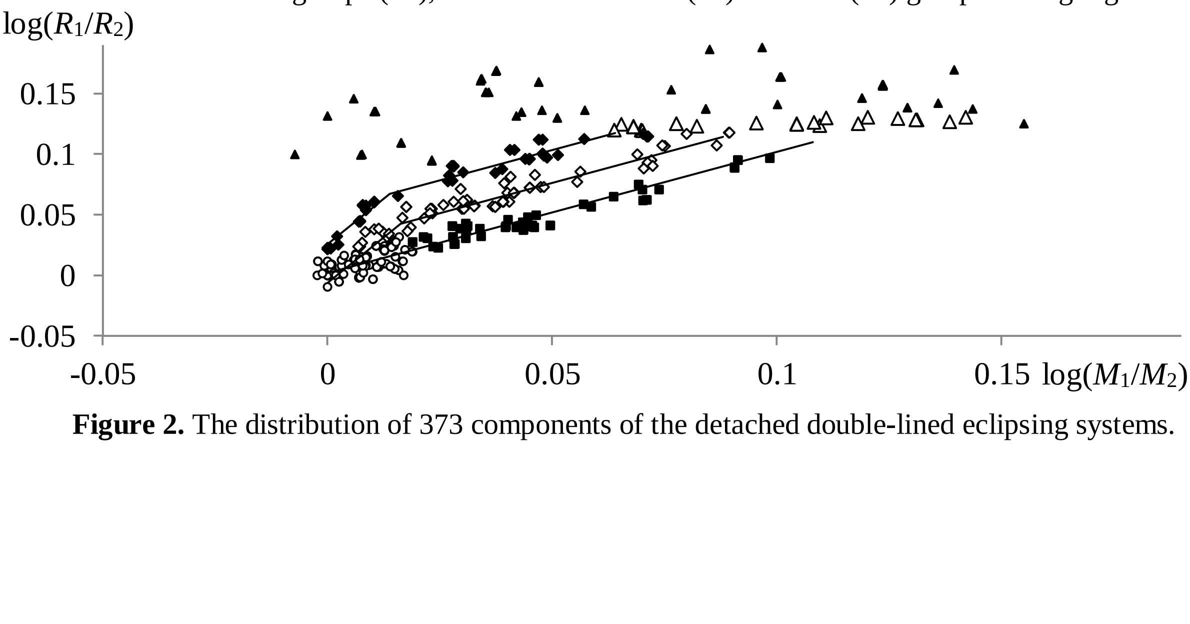

Figure 2. The distribution of 373 components of the detached double-lined eclipsing systems.

$R_1/R_2 \propto (M_1/M_2)^3$ is valid only for 27% of the DDLESes. Moreover, this dependence exists with an increase in M_1/M_2 only up to (1.025 – 1.042) and in the second and third groups. Then it becomes true $R_1/R_2 \propto M_1/M_2$, and for 53% of the DDLESes.

This is the consequence of the action of the gravitational scale factor M_1/M_2. Namely,

$$R_1 = \kappa_1 M_1^3/(M_1/M_2)^{\omega} \quad (1a)$$

$$R_2 = \kappa_2 M_2^3(M_1/M_2)^{\omega} \quad (1b)$$

where κ is the reduced radius, depending on the age of the components, but not on M_1/M_2, ω is a positive parameter, $M_1/M_2 \geq 1$. Taking into account (1) $\omega = 1$ for the first group and, when $M_1/M_2 \geq 1.042$, for the second and third groups. For the fourth group $R_1/R_2 \propto$ const. Hence, $\omega = 1.5$. Thus, when M_1/M_2 and R_1/R_2 increase, the transition ω from 1 to 1.5 occurs and, thereby, the amplification of the action of the gravitational scale factor takes place.

Part. 2. Quantum gravitational effects of the second type. For $M_1/M_2 \geq 1.042$ and $\omega = 1$, the first, second, and third groups are located with the same step along the coordinate axis $\log(R_1/R_2)$. This is the consequence of the action of the quantum gravitational effect of the second type along the coordinate axis $\log((GM/R)_1/(GM/R)_2)$ in the relative evolutionary expansion of the first and second components. Figure 3 shows the distribution of the DDLESes along this axis.

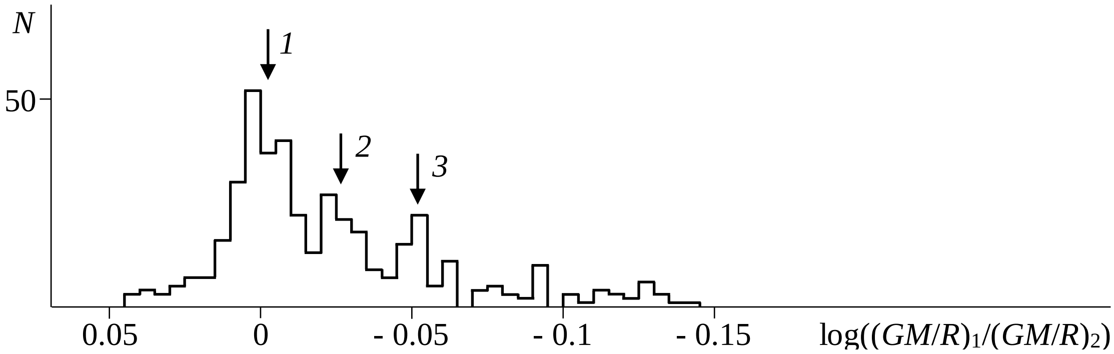

Figure 3. The distribution of 422 detached double-lined eclipsing systems.

Three peaks are visible, the positions of which are determined as

$$\log((GM/R)_1/(GM/R)_2) = -\,0.0248n - 0.0022,\ n = 0, 1, 2$$

Figure 4 shows the distribution of the DDLESes along the coordinate axis $\log(R_1/R_2)$.

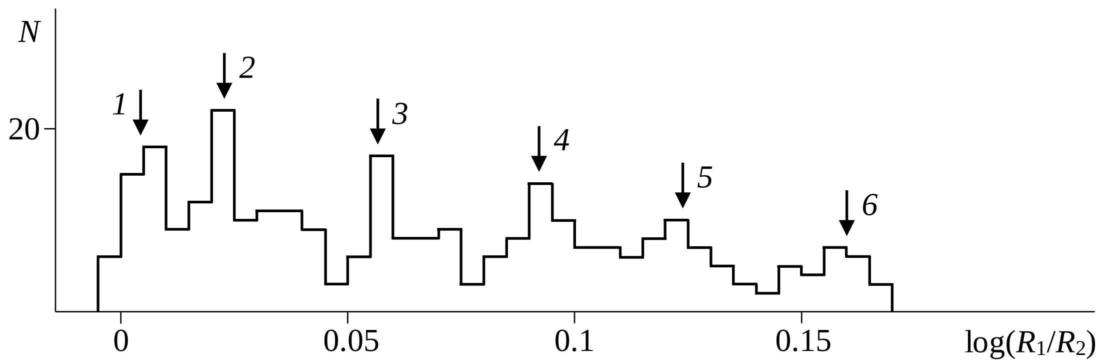

Figure 4. The distribution of 295 detached double-lined eclipsing systems.

Six peaks are visible, the positions of which are determined as

$$\log(R_1/R_2) = 0.0085n - 0.0027,\ n = 0, 3, 7, 11, 15, 19 \quad (2)$$

Hence, the quantum gravitational effect of the second type exists along the coordinate axis $\log(R_1/R_2)$. The quantum gravitational effect of the second type is also found along the axis $\log(g_1/g_2)$.

Note that, according to (2) along the coordinate axis $\log(R_1/R_2)$, the distance between the nearest populated areas increases by a multiple of the quantization step with increasing n. A similar change in this distance is also observed for the quantum gravitational effect of the second type along the coordinate axis $\log(g_1/g_2)$.

Conclusion:

1. In figures 3 and 4 the peaks are created by the populated areas of the temporal coordinated evolutionary expansion of the first and second components.
2. The relative evolutionary expansion of the first and second components is, in particular: their transitions along the coordinate axes $\log((GM/R)_1/(GM/R)_2)$, $\log(R_1/R_2)$ and $\log(g_1/g_2)$ between these areas and their temporary localization in the latter. In this case, the gravitational scale factor can additionally compress and expand, respectively, the first and second components. Therefore, the evolutionary expansion of the component is complicated, although orderly.

References

[1] Malkov O Yu 2007 *Mon. Not. R. Astron. Soc.* **382** 1073

[2] Torres G, Andersen J and Giménez A 2010 *Astron. Astrophys. Rev.* **18** 67

[3] Eker Z, Bilir S, Soydugan F, Yaz Gökçe E, Soydugan E, Tüysüz M, Şenyüz T and Demircan O 2014 *Publ. Astron. Soc. Australia* **31** 24E

[4] Eker Z, Soydugan F, Soydugan E, Bilir S, Yaz Gökçe E, Steer I, Tüysüz M, Şenyüz T and Demircan O 2015 *Astron. J.* **149** 131

627
Gravitational scale factor and quantum gravitational effect in luminosity of components of detached double-lined eclipsing systems (DDLESes)

S. V. Sinitsyn
s.sinitsyn@mail.ru

Introduction. The DDLES is consists of two very close stars which are the first and second components. The distance between these components is on the order of 1 or 10 solar radii. Indexes 1 and 2 indicate the first and second components, respectively.

If a quantum gravitational effect is carried out along the coordinate axis of the ratio of the values of any parameter of the first and second components, then it is of the second type.

Using empirical data from catalogs [1 - 4].

Part. 1. Gravitational scale factor. It is found that for the components with masses from 0.445 to 14.10 solar masses

$$L = \eta M^4, \tag{1}$$

where L, η, M are the luminosity, the reduced luminosity and the mass of the component, respectively.

Figure 1 shows the distribution of the DDLESes.

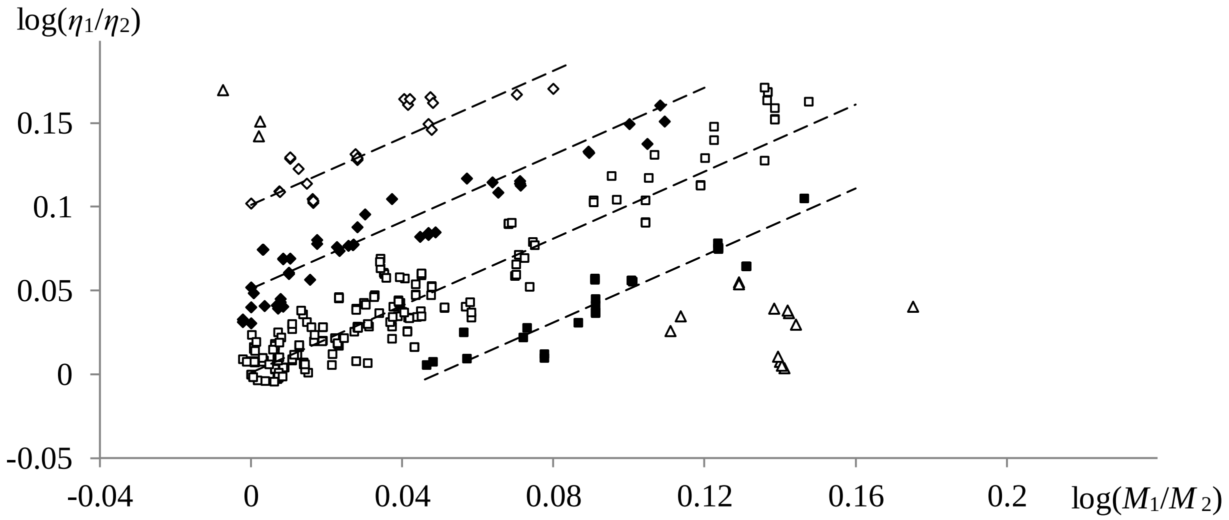

Figure 1. The distribution of 422 detached double-lined eclipsing systems.

The first (■), second (□), third (◆), fourth (◇), fifth (△) groups are divided.

For the first four groups

$$\log(\eta_1/\eta_2) = \log(M_1/M_2) + q,\ q = 0.0500n + 0.0010,\ n = -1, 0, 1, 2, \tag{2}$$

moreover $M_1/M_2 \geq 1$.

Hence, with a minimum deviation from (1) in the first four groups, for the first and second components L is determined as

$$L_1 = \eta^*_1 M_1^4 (M_1/M_2)^{1/2}$$

$$L_2 = \eta^*_2 M_2^4 / (M_1/M_2)^{1/2}$$

where M_1/M_2 is the gravitational scale factor, η^* is the reduced luminosity of the component in the absence of the gravitational scale factor action.

Nucleosynthesis is carried out in the central part of a star. Therefore the obtained result can indicate that in the first component the central part is compressed additionally, while in the second component, on the contrary, it is expanded additionally. This leads, respectively, to the increase and decrease of the nucleosynthesis of the first and second components. In this case, additional compression and expansion are determined by the gravitational scale factor in the form of M_1/M_2.

Part. 2. The quantum gravitational effect of the second type.

According to (1 – 3)

$q = \log(\eta^*_{(1)} / \eta^*_{(2)})$

Then, the latter parameter is quantized in the form of (2).

As a result, the quantum gravitational effect of the second type is found along the coordinate axis $\log(\eta^*_{(1)}/\eta^*_{(2)})$.

Conclusion:

1. In the DDLES, there is some quantum physical system which creates the quantum gravitational effect of the second type in the ratio of the luminosities of the first and second components.
2. A general gravitational mass of the DDLES is proposed as the quantum physical system.

References

[1] Malkov O Yu 2007 *Mon. Not. R. Astron. Soc.* **382** 1073

[2] Torres G, Andersen J and Giménez A 2010 *Astron. Astrophys. Rev.* **18** 67

[3] Eker Z, Bilir S, Soydugan F, Yaz Gökçe E, Soydugan E, Tüysüz M, Şenyüz T and Demircan O 2014 *Publ. Astron. Soc. Australia* **31** 24E

[4] Eker Z, Soydugan F, Soydugan E, Bilir S, Yaz Gökçe E, Steer I, Tüysüz M, Şenyüz T and Demircan O 2015 *Astron. J.* **149** 131