A Model of a Gravitational Flux Tube between Two Stars

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Abstract:

The narrow cones of space-time between two distant stars have a very special geometry which results in radially bending the geodesics toward the line-of-centers between these two stars. This geometry also bends adjacent geodesics, which would have missed the disks of these two stars, to intersect their disks. According to papers by professor Alexandre Deur, space interacts with itself. The hypothesis of this paper is that these self-interactions bend geodesics. For stars separated by many light years, this mechanism will increase gravity between these two stars. The result is the empirical equation of Modified Newtonian Dynamics by M. Milgrom.

This paper attempts to make a mathematical model quantifying the result of this slight bending of geodesics over long distances of many light years. A second term needs to be added to Newton's law of Universal Gravitation to correctly account for the orbital velocities of stars in our galaxy.

These extremely narrow tubes may be considered gravitational flux tubes. The light from the distant star will follow the geodesics of the flux tube. The light from the star, when the telescope is precisely aligned on the line-of-centers, will be brighter than when slightly off the line. If a distant star can be found that is less than 1 milli arc-second off the ecliptic plane, an observation by a telescope located on Earth may be possible. If no star can be found, then the observing telescope needs to be in space and be very precisely angularly aligned. If there is no difference in the measurements, then the above hypothesis is false.

Main Paper:

$$\boldsymbol{F_{gms} = \frac{GM_f m_s}{r^2} + \sqrt{Ga_0}\left(\frac{\sqrt{M_f}}{r}\right)m_s} \qquad \textbf{[1]}$$

F_{gms} = gravitational force on star s with mass m_s due to gravitation field radiating from star f

G = the gravitational constant G = 6.67×10^{-11} N·m^2 / kg^2 Ref. 1

M_f = Mass of star f m_s = mass of star s r = distance between stars f and s

$a_0 \approx (1.2 +/- 0.2) \times 10^{-10}$ m / s^2 estimated by M. Milgrom Ref. 2

On a galactic scale, the above is a proposed equation of the gravitational force on star s due to the gravitational field radiating from star f.

(Note: On a galactic scale, the gravitational forces on star f and star s are only equal if the masses of both stars are equal. Otherwise, on a galactic scale, the gravitational force on a star with the larger mass will be larger by the force ratio: $F_{ratio}\sqrt{\frac{M_L}{M_s}}$. This is possible, since we know from LIGO that gravity is a local effect.)

$$\frac{GM_f m_s}{r^2} \qquad [2]$$

The above equation is Isaac Newton's Law of Universal Gravitation. Ref. 1

Equation [2] applies at the scale of the solar system.

$$\sqrt{Ga_0}\left(\frac{\sqrt{M_f}}{r}\right)m_s \qquad [3]$$

Equation [3] is the empirical equation proposed by Mordecai Milgrom, **called Modified Newtonian Dynamics, or MOND**. Ref. 2

Equation [3] applies at the scale of the Milky Way galaxy. It correctly predicts the flat rotation curves of stars at large distances. Ref. 3

New constant $a_0 = 1.2 \times 10^{-10}$ m / s^2 applies. Ref. #2 estimated by M. Milgrom

Comparing Newtonian acceleration and Mondian acceleration:

$$\frac{GM_f}{r^2} \quad \rightarrow \quad \sqrt{Ga_0}\left(\frac{\sqrt{M_f}}{r}\right) \qquad [4]$$

Newton's term MOND's term

At solar system distances, the strength of the gravitational field decreases as $1/r^2$.

At galactic distances, the acceleration changes asymptotically to 1/r as the distance between stars greatly increases. Ref. 2

At longer distances, about above 1 light year, Mondian acceleration becomes dominant. The mass disk of star f becomes an almost infinitesimal point and the cone becomes almost a line. The mathematical result is the square root of the Newtonian acceleration. At 10,000 lightyears, Newton's term contributes only 1/100,000 of the gravitational acceleration as MOND's term. The main result of 1/r is that gravity will decrease much slower with distance. **Asymptotic** means that as r increases, the Newtonian contribution contributes less and less, and the Mondian contribution contributes more and more to the acceleration at star s.

What could cause this increase in gravitational force between stars? M. Milgrom proposed MOdified Newtonian Dynamics to account for the higher rotational velocities of stars in the Milky Way galaxy. MOND is an empirical equation. Ref. 4

Please look at Fig. 4. The resultant gravitational force vectors between two stars always point towards the line-of-centers between these two stars. In any plane, the resultants radially point towards the line-of-centers. The geodesics are dynamically bent towards the line-of-centers.

Please look at Fig. 10. **Over very long distances, of hundreds or thousands of light years, adjacent geodesics, that would have missed the star, are very slightly bent to intersect its disc. Since there are more geodesics intersecting the disk of the star, the acceleration due to gravity is increased. In my spreadsheets, the radius of the compressed disc is determined by the MOND term.** Please refer to spreadsheet #1, column F showing the ration of ring of geodesics being compressed to radius of sun.

But there is another effect: **The radial bending of geodesics will result in photons from star f to follow the bent geodesics. When viewed from star s, star f will appear much brighter than as viewed a few arc seconds off the line-of-centers between these two stars.**

If the above hypothesis is true, then I predict that stars, when viewed from the line-of-centers between the distant star and our Sun, will appear much brighter. At first, I hoped that **once a year**, the apparent brightness of stars, located very close to the ecliptic plane, will increase very, very slightly. As later calculations will show, about 16 trillionths of normal brightness for star Alpha Leonis when viewed from a telescope on Earth. (The extremely low increase in brightness is due to Alpha Leonis' ß= +o.466° of the ecliptic plane.) I do not think that it will be possible to distinguish such a miniscule change in brightness. Further calculations show that if Alpha Leonis is viewed precisely on the line of centers between our Sun and Alpha Leonis, then the star's brightness will increase by 366 times as when viewed just a few arc seconds off that line. (See spreadsheet #1, row 11, column I). A telescope in space will need to be parallel within 1 milli arc sec to the line-of-centers between centers of the Sun and any star. **If this is found not to be the case, then my hypothesis is wrong.**

Note: In most of this paper, star A or star f are distant stars and star B or star s is our Sun.

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Fig. 4

ALL RESULTANT GRAVITATIONAL VECTORS POINT RADIALLY TOWARDS THE CENTER

(Y) VERTICAL DISTANCES HAVE BEEN MULTIPLIED BY APPROXIMATELY 10^8

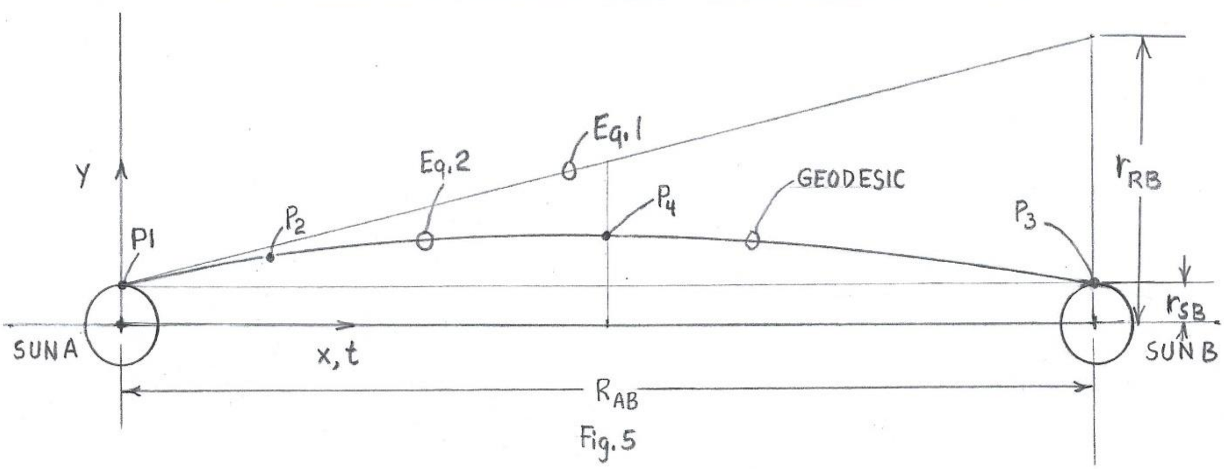


Fig. 5

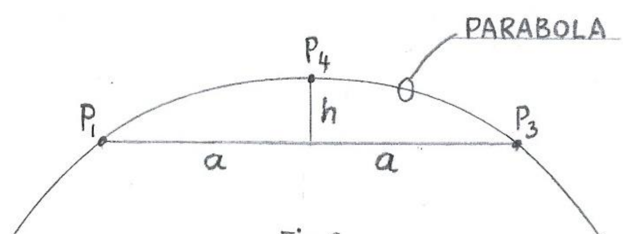
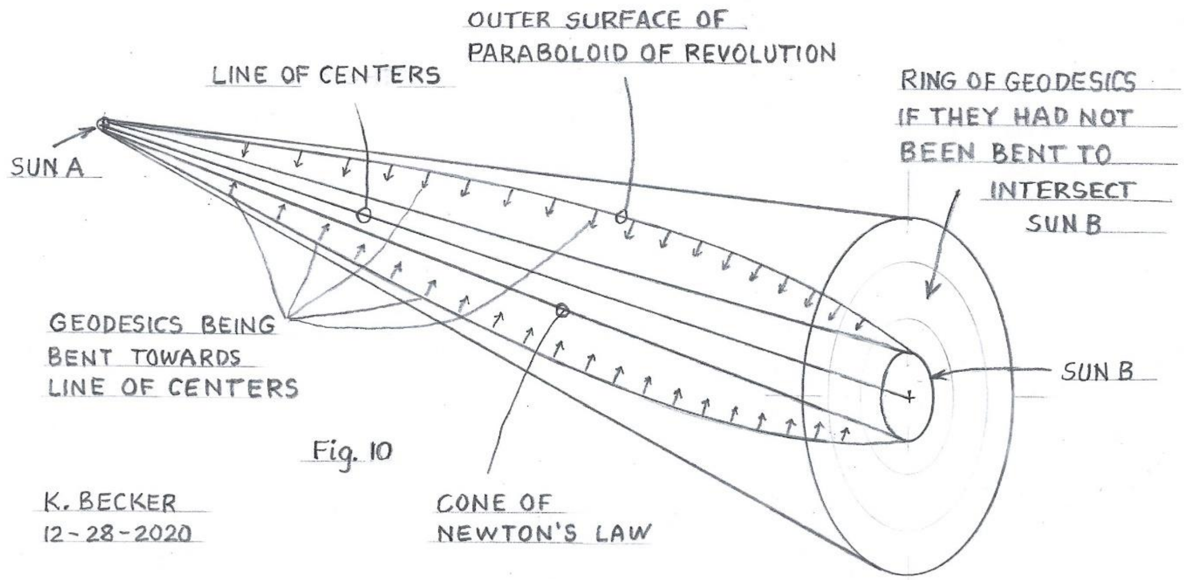


Fig. 6

ARC LENGTH $L_{P_1P_3} = \sqrt{a^2+4h^2} + \frac{a^2}{2h}\sinh^{-1}\left(\frac{2h}{a}\right)$ OF PARABOLIC SEGMENT $y = h\left(1-\frac{x^2}{a^2}\right)$


OUTER SURFACE OF
PARABOLOID OF REVOLUTION
LINE OF CENTERS
RING OF GEODESICS
IF THEY HAD NOT
BEEN BENT TO
INTERSECT
SUN B
SUN A
GEODESICS BEING
BENT TOWARDS
LINE OF CENTERS
SUN B
CONE OF
NEWTON'S LAW
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12-28-2020

Fig. 10

In Fig. 6 The length of the parabola of the geodesic is mathematically only very, very slightly longer than a straight line (Euclidian) due to the enormous distances between stars. The calculations are not shown to keep this paper simpler.

Please refer to Fig. 5. What type of curve will it be? It needs to fit between rays y = 0 and y = ($3.71 \cdot 10^{-8}$) x in radians. Note the very small angle of 7.67 milli arc seconds. The geodesic starts out as a parabola $y = ax^2 + bx + c$, for most of its length. Coefficient a will be a very small negative number and b will the initial slope, dy/dx.

Use 2-points and one slope at one those points to find equation of parabola.

The x-axis is line of centers between stars A and B.

Since the angles are extremely small, the arc length of the geodesic is only very slightly longer than the distance between the stars. Arc length = R_{AB} at 4-digit precision. See Figure 6 for formula of arc length. It is assumed here that the probability of interactions is the same along the geodesic, which is not exactly true, as we shall see later.

$y = ax^2 + bx + c$; use point P1 and slope at P1 and point P3

P1 = (0.000, 6.96 x 10^8) in m at top of sun

P1 = (0.000, 0.000) in m at center of sun

P1 = (0.000, -6.96 x 10^8) in m at bottom of sun

Any of the 3 positions of P1 are effectively the same, since the whole star is a point considering the distance of 4.73 x 10^{17} m between the two stars.

Tan θ at P1 = 3.71 x 10^{-8}

Arc tan 3.71 x 10^{-8} = 2.13 x 10^{-6} degrees = 0.00767 arc sec

The geodesic will be bent by **(**7.67 x 10^{-3} sec)/ in 25 years = 0.000307 sec / year
= 307 micro-sec / year

In 50 years, the outermost geodesic will be bent by 15.34 milli arc sec

P3 = (4.73 x 10^{17}, 6.96 x 10^8) in m

Substituting points in general equation to find a, b, c

(1) At P1 y = **6.96 x 10^8m = c**

(2) 6.96 x 10^8 = a (4.73 x 10^{17})^2 + b (4.73 x 10^{17}) + (6.96 x 10^8)

(3) $y = ax^2 + bx + c$

(4) $dy/dx = 2ax + b$

When x = 0, **b = 3.71 x 10^{-8}**

(5) 6.96 x 10^{8} = a (4.73 x 10^{17})^{2} + (3.71 x 10^{-8}) (4.73 x 10^{17}) + (6.96 x 10^{8})

(6) 6.96 x 10^{8} = a (22.37 x 10^{34}) + 17.55 x 10^{9} + (6.96 x 10^{8})

(2) 6.96 x 10^{8} – 175.5 x 10^{8} –6.96 x 10^{8} = a (22.37 x 10^{34})

(2) – 175.5 x 10^{8} = a (2.237 x 10^{35})

(2) **– 78.45 x 10^{-27} = -7.845 x 10^{-26}**

Equation 2T: y = - 7.85 · 10^{-26} x^{2} + 3.71 ·10^{-8} x + 6.96 · 10^{8} using P1 at top [5T]

Equation 2C: y = - 7.85 · 10^{-26} x^{2} + 3.71 ·10^{-8} x using P1 at center [5C]

Equation 2B: y = - 7.85 · 10^{-26} x^{2} + 3.71 ·10^{-8} x - 6.96 · 10^{8} using P1 at bottom [5B]

Any of the above equations are valid. The important coefficients are the small, negative coefficient of x^{2} and the much larger positive coefficient of x. In this equation, 3.71 ·10^{-8}, is the initial tangent of the geodesic.

The equation 2 [17] will change due to the distances, mass and diameters of stars involved.

The observations of the higher velocities of stars in our galaxy and the resulting MOND equation and constant a_0, justify that the outer geodesic from star A to star B bends sufficiently resulting in above equations 5T, 5C and 5B.

Some MOND Basics quoted from Ref. 3: "The MOND acceleration of gravity a is related to Newtonian acceleration a_N by

$$a_N = a\mu\left[\frac{a}{a_0}\right] \quad \textbf{[6]}$$

The constant a_0=1.2 +/- 0.2 x 10^{-8} cm/s^{2} is meant to be a new constant of physics.

The interpolation constant μ(a/a_0) admits the asymptotic behavior μ=1 for $a \gg a_0$, so to retrieve the Newtonian expression in the strong field regime, and μ=a/a_0 for $a \ll a_0$." (In the deep-MOND limit) Ref. 2

Some relations defining Newton's acceleration, a_N, and MOND's acceleration, a_M. Ref. 1, 2, 3

$$a_N = \frac{GM}{r^2} \quad \textbf{[7]}$$

In strong acceleration limit. From Newton's Universal Gravitation.

$$a_M = \frac{\sqrt{GMa_0}}{r} = g_M \quad \textbf{[8]}$$

In weak acceleration limit. Formula is from Modified Newtonian Dynamics Ref. 3

$$a_M = \sqrt{a_N a_0} \quad \textbf{[9]}$$

$$\frac{\sqrt{MA_0}}{r} = \sqrt{a_N a_0} \quad \textbf{[10]}$$

MOND constant $A_0 = Ga_0 = 8.00 \times 10^{-21}$ m^4/kg-s^4. **[11]**

Spreadsheet #1 below shows the relative magnitudes of accelerations by using Newton's and MOND formulas.

The accelerations are equal ($a_N = a_M$ at 1.05E+15m) at 0.111 light years between two stars. It is surprising that at such a short distance Newtonian gravity and modified Newtonian gravity have an equal effect.

It must be kept in mind, that the data of Tycho Brahe was taken from our solar system and used by Kepler to formulate his three laws. The velocities of stars in our galaxy are other data sets from which Milgrom estimated a_0. Milgrom's empirical equation is analogous to Kepler's third law.

Refer to Fig. 5: The hypotheses in this paper that the increased effect of a_{MA} is due to the compression of geodesics within ring r_{RB} into the disk of our Sun, r_{SB}.

$$\frac{a_{MA}}{a_{NA}} = \frac{A_{RB}}{A_{SB}} \quad \textbf{[12]}$$

a_{MA} = acceleration due to distant sun A and MOND

a_{NA} = acceleration due to distant sun A and Newton's formula

A_{SB} = area of disk of sun B, our Sun (facing sun A)

A_{RB} = area of ring around sun B, our Sun (facing sun A)

$A_{SB} = \pi r^2_{SB}$ r_{SB} =radius of sun B

$A_{RB} = \pi r^2_{RB} - \pi r^2_{SB}$ r_{RB} = outer radius of ring around sun B

$$\frac{a_{MA}}{a_{NA}} = \frac{\pi(r_{RB}^2 - r_{SB}^2)}{\pi r_{SB}^2} \qquad [13]$$

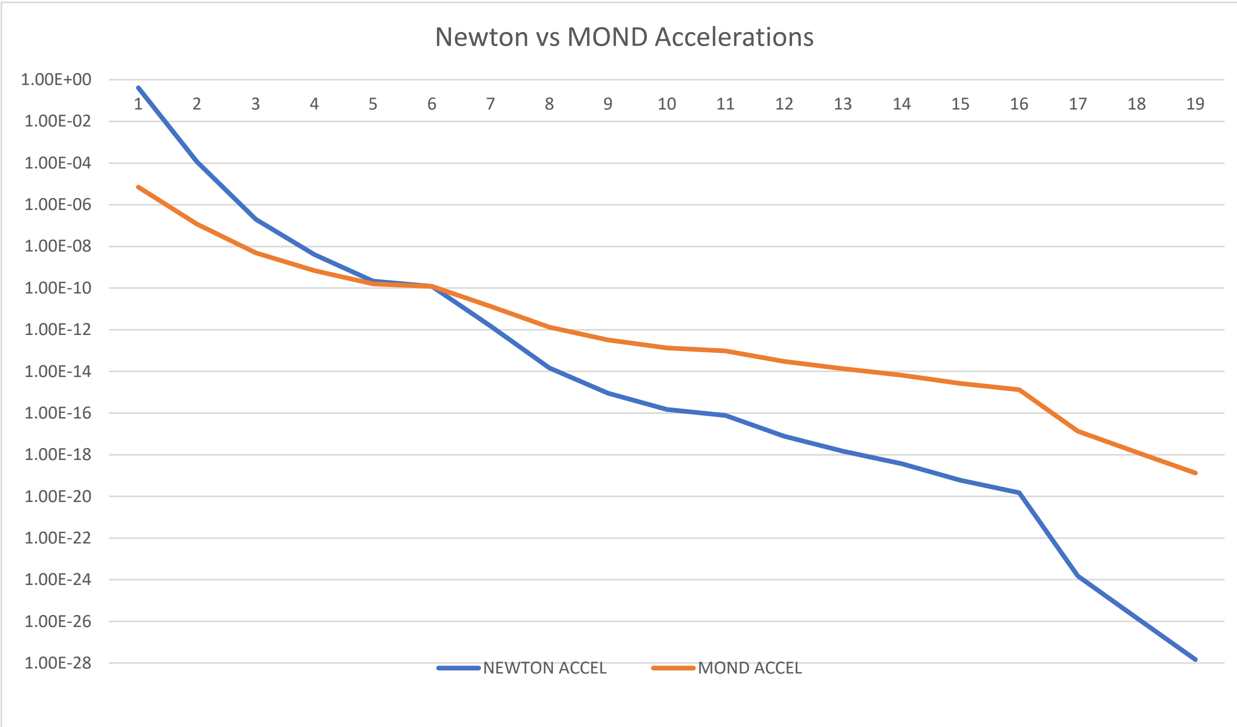
$$\frac{a_{MA}}{a_{NA}} r^2{}_{SB} + r^2{}_{SB} = r^2{}_{RB}$$

$$\left(\frac{a_{MA}}{a_{NA}} + 1\right) r^2{}_{SB} = r^2{}_{RB}$$

$$\sqrt{\frac{a_{MA}}{a_{NA}} + 1}\,(r_{SB}) = r_{RB} \qquad [14]$$

The spreadsheet below shows the relative strengths of Newtonian and Mondian accelerations at various distances between stars.

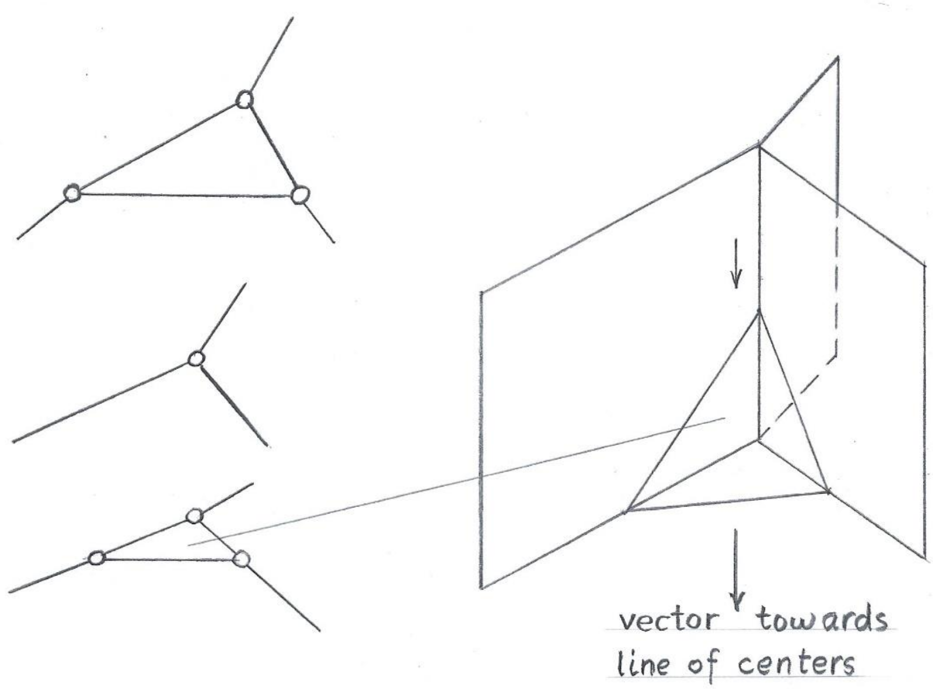
	A	B	C	D	E	F	G	H	I
1	**Distances between two stars**	**Spreadsheet #1**	$a_N = \frac{GM}{r^2}$	$a_M = \sqrt{a_N a_0}$	$g_M = \frac{\sqrt{MA_0}}{r}$	$\frac{r_{RB}}{r_{SB}} = \sqrt{\frac{a_M}{a_N} + 1}$	$a_T = a_N + a_M$	**M**	$\Delta B = \frac{a_M}{a_N} + 1$ $\Delta B = \frac{\pi r_{RB}^2}{\pi r_{SB}^2}$
2	r (R_{AB})*	Distance light travels in			$a_M = g_M$	Ratio of radius of ring to radius of sun disk	Sum of acclerations	Mass of distant star	Change in Brightness
3	1.80E+10	one minute	4.10E-01	7.01E-06	7.01E-06	1.0000E+00	4.10E-01	1.99E+30	1.0000E+00
4	1.08E+12	one hour	1.14E-04	1.17E-07	1.17E-07	1.0005E+00	1.14E-04	1.99E+30	1.0010E+00
5	2.59E+13	one day	1.98E-07	4.87E-09	4.87E-09	1.0122E+00	2.02E-07	1.99E+30	1.0246E+00
6	1.82E+14	one week	4.01E-09	6.94E-10	6.94E-10	1.0830E+00	4.70E-09	1.99E+30	1.1730E+00
7	7.88E+14	one month	2.14E-10	1.60E-10	1.60E-10	1.3227E+00	3.74E-10	1.99E+30	1.7496E+00
8	1.05E+15	$a_N = a_M$	1.20E-10	1.20E-10	1.20E-10	1.4143E+00	2.40E-10	1.99E+30	2.0003E+00
9	9.46E+15	one year	1.48E-12	1.33E-11	1.33E-11	3.1615E+00	1.48E-11	1.99E+30	9.9948E+00
10	9.46E+16	ten years	1.48E-14	1.33E-12	1.33E-12	9.5367E+00	1.35E-12	1.99E+30	9.0948E+01
11	7.47E+17	Alpha Leonis	9.03E-16	3.29E-13	3.29E-13	1.9119E+01	3.30E-13	7.56E+30	3.6553E+02
12	9.46E+17	hundred years	1.48E-16	1.33E-13	1.33E-13	3.0008E+01	1.34E-13	1.99E+30	9.0048E+02
13	1.70E+18	Delta Cancri	7.78E-17	9.66E-14	9.66E-14	3.5253E+01	9.67E-14	3.38E+30	1.2428E+03
14	2.93E+18	Kappa Librae	7.72E-18	3.04E-14	3.04E-14	6.2804E+01	3.04E-14	9.95E+29	3.9444E+03
15	9.46E+18	thousand years	1.48E-18	1.33E-14	1.33E-14	9.4846E+01	1.33E-14	1.99E+30	8.9958E+03
16	1.89E+19	two thousand	3.71E-19	6.67E-15	6.67E-15	1.3413E+02	6.67E-15	1.99E+30	1.7991E+04
17	2.84E+19	three thousand	1.65E-19	4.45E-15	4.45E-15	1.6427E+02	4.45E-15	1.99E+30	2.6985E+04
18	3.78E+19	four thousand	9.27E-20	3.34E-15	3.33E-15	1.8968E+02	3.34E-15	1.99E+30	3.5980E+04
19	4.73E+19	five thousand	5.93E-20	2.67E-15	2.67E-15	2.1207E+02	2.67E-15	1.99E+30	4.4975E+04
20	9.46E+19	ten thousand	1.48E-20	1.33E-15	1.33E-15	2.9992E+02	1.33E-15	1.99E+30	8.9949E+04
21	9.46E+21	million ly	1.48E-24	1.33E-17	1.33E-17	2.9991E+03	1.33E-17	1.99E+30	8.9948E+06
22	9.46E+22	ten million ly	1.48E-26	1.33E-18	1.33E-18	9.4841E+03	1.33E-18	1.99E+30	8.9948E+07
23	9.46E+23	hundred million	1.48E-28	1.33E-19	1.33E-19	2.9991E+04	1.33E-19	1.99E+30	8.9948E+08
24									
25		**Constants**							
26	Values	Symbols	in Units						
27	9.46E+15	ly	m	All constants from Wikipedia					
28	6.67E-11	G	m^3/kgs^2	Gravitational constant					
29	1.99E+30	M_{SUN}	kg	M = mass of distant star causing gravitational field; the same as our Sun's mass, except as noted.					
30	1.20E-10	a_0	m/s^2	Estimated by M. Milgrom					
31	8.00E-21	A_0	m^4/kgs^4	A_0 = G*a by M. Milgrom					
32									
33	3.80E+00	Alpha Leonis mass = 3.8 times the mass of 0ur Sun; data from wikipedia wiki/Regulus							
34	1.70E+00	Delta Cancri mass = 1.7 mass of Sun; data from wikipedia wiki/Delta_Cancri							
35	5.00E-01	Kappa Librae mass = 0.5 mass of Sun; from chart wikipedia wiki/ stellar classifications							
36	File name: Acceleration Newton's vs MOND Formulas								
37	File location: This PC/Documents/Amplification Effect of Gravitons/								
38	r (RAB)* in later spreadsheets the distance between two stars will be designated by RAB								
39									
40	Values of change in brightness of stars Alpha Leonis, Delta Cancri and Kappa Librae are only true if viewed from a line of centers between star and our Sun.								
41	All other values assume that star lies pecisely on ecliptic plane, with β = 0								



In the above chart, notice the blue line, due to Newtonian acceleration, is steeper than the brown line, which is due to MONDian acceleration. Gravitation decreases much more slowly when the Mondian regime is dominant at large distances. The bumps in the middle are the stars Alpha Leonis, Delta Cancri, Kappa Librae. (Vertical axis is logarithmic.)

According to Loop Quantum Gravity (Ref. 6), there is a minimum area and volume of space. Space is granular and consist of spin networks. Spin networks contain a node with a designated volume and lines connecting to adjacent nodes of ½ integer spins. A formula to calculate the area separating two grains of space is shown on page 166 referenced in book "Reality is Not What it Seems".

$$A_{J1/2} = 8\pi L_P^2\sqrt{j(j+1)} \qquad [15]$$



Evolving Spin Neworks result in Spin Foam – LQG

Fig. 2

Fig. 2 tries to show how nodes are moved. They are first deleted and then created. In effect, this moves the geodesic closer to the line of centers.

	A	B	C	D	E	F
1	**Spreadsheet #2j**		**Planck length squared**	**Spectrum of minimal areas**	**Height**	**Volume**
	j spin	$\sqrt{j(j+1)}$	L_p^2	$A = 8\pi L_P^2 \sqrt{j(j+1)}$	$\sqrt{A}$	$(\sqrt{A})^3$
3						
4	1/2	8.6603E-01	2.6123E-70	5.6858E-69	7.5404E-35	4.2873E-103
5	1	1.4142E+00	2.6123E-70	9.2848E-69	9.6358E-35	8.9467E-103
6	1 1/2	1.9365E+00	2.6123E-70	1.2714E-68	1.1276E-34	1.4336E-102
7	2	2.4495E+00	2.6123E-70	1.6082E-68	1.2681E-34	2.0394E-102
8	2 1/2	2.9580E+00	2.6123E-70	1.9421E-68	1.3936E-34	2.7064E-102
9	3	3.4641E+00	2.6123E-70	2.2743E-68	1.5081E-34	3.4299E-102

Loop Quantum Gravity (LQG) theory posits that space is granular. LQG is used to calculate minimum areas of space. Ref. 6

From Spreadsheet #2j, the spin network A_J used for this calculation is A_J **=** $\mathbf{A_{J5/2}}$ **=** 1.9421 x 10^{-68} m^2

The area of a parallelogram, shown in Fig. 9, is A◊ = c d sin(α+β) **[16]**

c = sqrt$A_{J5/2}$ / sin(α+β) d = sqrt$A_{J5/2}$ / sin(α+β) **[17]**

A◊ = [sqrt$A_{J5/2}$ / sin(α+β)] [sqrt$A_{J5/2}$ / sin(α+β)] [sin(α+β)]

A◊ = $\mathbf{A_{J5/2}}$ **/ sin(α+β) = base** **[18]**

V = base x height height = $(\mathbf{A_{J5/2}})^{1/2}$

V = $\mathbf{(A_{J5/2})^{3/2}}$ **/ sin(α + β)** Volume of spin network (if its shape is a cube). [**19**]

Note point P_G is on a particular point along the geodesic, that is, it is on a particular parabola.

Dividing equation [24] by the volume of the spin network results in the number of possible interactions sites.

$$\frac{\mathbf{1}}{\boldsymbol{sin(\alpha+\beta)}}$$ **[20]**

The probability of gravitational vectors interacting depends greatly on their very nearly parallel paths. The smaller the angles α + β are, the greater the probability of interaction. In Fig. 8 the numbers refer to volumes of spin networks stacked upon each other. The vertical grid lines are $\sqrt{A_j}$. The associated spreadsheet is #3.

Quoting A. Deur, University of Virginia: “Graviton-graviton interactions increase the gravitational binding of matter.” And further on, he compares the interactions of gluons with each other inside nucleons to the interactions of gravitons with each other. Ref. 4

Spreadsheet #3 compares angles at the spin network scale with the probability of the two gravitational vectors between two stars to interact. Refer to columns D, E and H. The numbers of possible interaction sites are huge, of the order of 10^{50}. Spreadsheet #4A compares angles of gravitational vectors at the outer envelope of the ring of geodesics to be compressed at the distance of star Regulus. Compare columns G, H, and K of spreadsheet #4A to similar columns of spreadsheet #3. You will notice that the number of possible interaction sites decreased from 10^{50} to 10^{7}**. This shows that the bending quickly decreases as the angles (α + β) only slightly increase**. **The minimum volumes of the spin networks is key to the amount of bending of geodesics.** (Also refer to spreadsheet 2j). As a limit, if the (α+β) = π/2 then the interaction is only $1/10^{50}$. (This is highlighted in beige on spreadsheet #4B). At large angles of intersection, gravitons will essentially not interact. **Only in the very parallel beams between stars is there any interaction. Outside of these beams there is almost no interaction.**

Spreadsheet #3

	A	B	C	D	E	F	G	H	I
1	**Spreadsheet #3**								
2	Number of **n** spin networks	$\tan\alpha = \frac{n\sqrt{A_j}}{x}$	$\tan\beta = \frac{n\sqrt{A_j}}{R_{AB} - x}$	$\arctan\frac{n\sqrt{A_J}}{x} = \alpha$	$\arctan\frac{n\sqrt{A_J}}{R_{AB} - x} = \beta$	$(\alpha + \beta) =$		$V_{isec} = \frac{(A_j)^{\frac{3}{2}}}{\sin(\alpha + \beta)}$	$N_{pact} = \frac{1}{\sin(\alpha + \beta)}$
3	Data →	$R_{AB} = 4.73 \cdot 10^{17}$ m	Let x = 1/2 R_{AB}	$A_{J5/2} = 1.941 \times 10^{-68}$ m^2	α and β are in radians	Sum of base angles in radians	Sum of base angles in degrees	V_{isec} = volume of intersection $A_j^{3/2} = 2.704 \times 10^{-102}$	Npact = Number of possible interaction sites
4	0								
5	1	5.8909E-52	5.8909E-52	5.8909E-52	5.8909E-52	1.17818E-51	6.75047E-50	2.29523E-51	8.48767E+50
6	2	1.17818E-51	1.17818E-51	1.17818E-51	1.17818E-51	2.35636E-51	1.35009E-49	1.14762E-51	4.24383E+50
7	3	1.76727E-51	1.76727E-51	1.76727E-51	1.76727E-51	3.53454E-51	2.02514E-49	7.65077E-52	2.82922E+50
8	4	2.35636E-51	2.35636E-51	2.35636E-51	2.35636E-51	4.71272E-51	2.70019E-49	5.73808E-52	2.12192E+50
9	5	2.94545E-51	2.94545E-51	2.94545E-51	2.94545E-51	5.8909E-51	3.37524E-49	4.59046E-52	1.69753E+50
10	6	3.53454E-51	3.53454E-51	3.53454E-51	3.53454E-51	7.06908E-51	4.05028E-49	3.82539E-52	1.41461E+50
11	7	4.12363E-51	4.12363E-51	4.12363E-51	4.12363E-51	8.24726E-51	4.72533E-49	3.2789E-52	1.21252E+50
12	8	4.71272E-51	4.71272E-51	4.71272E-51	4.71272E-51	9.42544E-51	5.40038E-49	2.86904E-52	1.06096E+50
13	9	5.30181E-51	5.30181E-51	5.30181E-51	5.30181E-51	1.06036E-50	6.07543E-49	2.55026E-52	9.43074E+49
14	10	5.8909E-51	5.8909E-51	5.8909E-51	5.8909E-51	1.17818E-50	6.75047E-49	2.29523E-52	8.48767E+49
15	100	5.8909E-50	5.8909E-50	5.8909E-50	5.8909E-50	1.17818E-49	6.75047E-48	2.29523E-53	8.48767E+48
16	1,000	5.8909E-49	5.8909E-49	5.8909E-49	5.8909E-49	1.17818E-48	6.75047E-47	2.29523E-54	8.48767E+47
17	10,000	5.8909E-48	5.8909E-48	5.8909E-48	5.8909E-48	1.17818E-47	6.75047E-46	2.29523E-55	8.48767E+46
18	100,000	5.8909E-47	5.8909E-47	5.8909E-47	5.8909E-47	1.17818E-46	6.75047E-45	2.29523E-56	8.48767E+45
19	1,000,000	5.8909E-46	5.8909E-46	5.8909E-46	5.8909E-46	1.17818E-45	6.75047E-44	2.29523E-57	8.48767E+44
20									
21									
22	Location of file: This PC/Documents/Amplification Effect of Gravitons/Spreadsheet #3 Number of possible interaction sites								

	A	B	C	D	E
1	**Spreadsheet #3-n2**				
2		**α rad = deg x π/180**	$n = \frac{\tan \alpha R_{AB}}{2\left(\sqrt{A_j}\right)}$	**sin (2α)**	**N_{pact} = 1/sin(2α)**
3	**arc degrees**	**arc in radians**	**Height in spin networks**		
4	1 arc degree	1.745329E-02	2.963056E+49	3.48994967E-02	2.86537083E+01
5	0.5 arc degree	8.726646E-03	1.481415E+49	1.74524064E-02	5.72986885E+01
6	0.2 arc degree	3.490659E-03	5.925534E+48	6.98126030E-03	1.43240612E+02
7	0.1 arc degree	1.745329E-03	2.962758E+48	3.49065142E-03	2.86479479E+02
8	1 arc min	2.908882E-04	4.937925E+47	5.81776385E-04	1.71887348E+03
9	1 arc second	4.848137E-06	8.229875E+45	9.69627362E-06	1.03132403E+05
10	1 milli arc sec	4.848137E-09	8.229875E+42	9.69627362E-09	1.03132403E+08
11	1 micro arc sec	4.848137E-12	8.229875E+39	9.69627362E-12	1.03132403E+11
12					
13	**A_j = 1.941 x 10^{-68} m^2 Area of spin network 5/2**				
14	**R_{AB} = 4.73 x 10^{17} m Distance between Alpha Leonis and our Sun**				
15					

Spreadsheet #4A

	A	B	C	D	E	F	G	H	I	J	K
1	n	$x = \frac{nR_{AB}}{16}$	$y = ax^2 + bx + c$	R_{AB} - x	$\tan \alpha = \frac{y}{x}$	$\tan \beta = \frac{y}{R_{AB} - x}$	arctan α	arctan β	(α + β) =	$V_{isec} = \frac{(A_j)^{\frac{3}{2}}}{\sin(\alpha + \beta)}$	$N_{pact} = \frac{1}{\sin(a + \beta)}$
2		R_{AB} = 4.73 ·10^{17} m Ref. 8	a = - 6.5961945 · 10^{-26} b = 3.12 · 10^{-8} c = 0 in m			$A_{J5/2}$ = 1.941 x 10^{-68} m^2		Volume of spin network is 2.704x10^{-102}	Sum is (α + β) constant	Visec = volume of intersection	Npact = Number of possible interaction sites
3	0	0	0	4.73E+17	0		0				
4	1	2.95625E+16	864,703,125	4.43438E+17	2.925E-08	1.95E-09	2.925E-08	1.95E-09	3.12E-08	8.6673E-95	32,051,282
5	2	5.9125E+16	1,614,112,500	4.13875E+17	2.73E-08	3.9E-09	2.73E-08	3.9E-09	3.12E-08	8.6673E-95	32,051,282
6	3	8.86875E+16	2,248,228,125	3.84313E+17	2.535E-08	5.85E-09	2.535E-08	5.85E-09	3.12E-08	8.6673E-95	32,051,282
7	4	1.1825E+17	2,767,050,000	3.5475E+17	2.34E-08	7.8E-09	2.34E-08	7.8E-09	3.12E-08	8.6673E-95	32,051,282
8	5	1.47813E+17	3,170,578,126	3.25188E+17	2.145E-08	9.75E-09	2.145E-08	9.75E-09	3.12E-08	8.6673E-95	32,051,282
9	6	1.77375E+17	3,458,812,501	2.95625E+17	1.95E-08	1.17E-08	1.95E-08	1.17E-08	3.12E-08	8.6673E-95	32,051,282
10	7	2.06938E+17	3,631,753,126	2.66063E+17	1.755E-08	1.365E-08	1.755E-08	1.365E-08	3.12E-08	8.6673E-95	32,051,282
11	8	2.365E+17	3,689,400,002	2.365E+17	1.56E-08	1.56E-08	1.56E-08	1.56E-08	3.12E-08	8.6673E-95	32,051,282
12	9	2.66063E+17	3,631,753,127	2.06938E+17	1.365E-08	1.755E-08	1.365E-08	1.755E-08	3.12E-08	8.6673E-95	32,051,282
13	10	2.95625E+17	3,458,812,503	1.77375E+17	1.17E-08	1.95E-08	1.17E-08	1.95E-08	3.12E-08	8.6673E-95	32,051,282
14	11	3.25188E+17	3,170,578,128	1.47813E+17	9.75E-09	2.145E-08	9.75E-09	2.145E-08	3.12E-08	8.6673E-95	32,051,282
15	12	3.5475E+17	2,767,050,004	1.1825E+17	7.8E-09	2.34E-08	7.8E-09	2.34E-08	3.12E-08	8.6673E-95	32,051,282
16	13	3.84313E+17	2,248,228,130	8.86875E+16	5.85E-09	2.535E-08	5.85E-09	2.535E-08	3.12E-08	8.6673E-95	32,051,282
17	14	4.13875E+17	1,614,112,505	5.9125E+16	3.9E-09	2.73E-08	3.9E-09	2.73E-08	3.12E-08	8.6673E-95	32,051,282
18	15	4.43438E+17	864,703,131	2.95625E+16	1.95E-09	2.925E-08	1.95E-09	2.925E-08	3.12E-08	8.6673E-95	32,051,282
19	16	4.73E+17	7	0		0		0			
20	SPREADSHEET #4A		Coefficient **a** = - 6.5961945 · 10-26 resulted in the bending of the outer geodesic such that it intersects the center of the Sun.								
21	Location of file: This PC/Documents/Amplification Effect of Gravitons/Spreadsheet #4A Outer Geodesic										

Spreadsheet #4B

	A	B	C	D	E	F	G	H	I	J	K
1	n	$x = \frac{nR_{AB}}{16}$	$y = ax^2$ + bx + c	R_{AB} - x	$\tan\alpha = \frac{y}{x}$	$\tan\beta = \frac{y}{R_{AB} - x}$	arctan α	arctan β	(α + β) =	$V_{isec} = \frac{(A_j)^{\frac{3}{2}}}{\sin(\alpha+\beta)}$	$N_{pact} = \frac{1}{\sin(a+\beta)}$
2		$R_{AB} = 4.73 \cdot 10^{17}$ m Ref. 8	a = - $6.2854 \cdot 10^{-26}$ b = $3.12 \cdot 10^{-8}$ c = $6.95 \cdot 10^{8}$ m	Radius of Sun = 695,000,000 m		$A_{J5/2} = 1.941 \times 10^{-68}\ m^2$		Volume of spin network is 2.704×10^{-102}	Sum of angles increases slightly	Visec = volume of intersection	Npact = Number of possible interaction sites
3	0	0	0	4.73E+17	0	0	0	0	0	9.18093E-51	3.39507E+51
4	0.0001	2.95625E+12	92,234	4.73E+17	3.11998E-08	1.95E-13	3.11998E-08	1.95E-13	3.12E-08	8.6673E-95	32,051,273
5	0.001	2.95625E+13	922,295	4.73E+17	3.11981E-08	1.95001E-12	3.11981E-08	1.95001E-12	3.12001E-08	8.66727E-95	32,051,188
6	0.01	2.95625E+14	9,218,007	4.73E+17	3.11814E-08	1.95006E-11	3.11814E-08	1.95006E-11	3.12009E-08	8.66704E-95	32,050,338
7	0.1	2.95625E+15	91,685,693	4.70E+17	3.10142E-08	1.95058E-10	3.10142E-08	1.95058E-10	3.12092E-08	8.66473E-95	32,041,787
8	1	2.95625E+16	867,419,287	4.43E+17	2.93419E-08	1.95613E-09	2.93419E-08	1.95613E-09	3.1298E-08	8.64016E-95	31,950,919
9	2	5.9125E+16	1,624,977,147	4.14E+17	2.74838E-08	3.92625E-09	2.74838E-08	3.92625E-09	3.141E-08	8.60935E-95	31,836,986
10	3	8.86875E+16	2,272,673,582	3.84E+17	2.56256E-08	5.91361E-09	2.56256E-08	5.91361E-09	3.15392E-08	8.57407E-95	31,706,530
11	4	1.1825E+17	2,810,508,590	3.55E+17	2.37675E-08	7.9225E-09	2.37675E-08	7.9225E-09	3.169E-08	8.53328E-95	31,555,677
12	5	1.47813E+17	3,238,482,171	3.25E+17	2.19094E-08	9.95882E-09	2.19094E-08	9.95882E-09	3.18682E-08	8.48556E-95	31,379,235
13	6	1.77375E+17	3,556,594,327	2.96E+17	2.00513E-08	1.20308E-08	2.00513E-08	1.20308E-08	3.2082E-08	8.42901E-95	31,170,093
14	7	2.06938E+17	3,764,845,056	2.66E+17	1.81932E-08	1.41502E-08	1.81932E-08	1.41502E-08	3.23434E-08	8.3609E-95	30,918,230
15	8	2.365E+17	3,863,234,359	2.37E+17	1.6335E-08	1.6335E-08	1.6335E-08	1.6335E-08	3.26701E-08	8.27729E-95	30,609,067
16	9	2.66063E+17	3,851,762,235	2.07E+17	1.44769E-08	1.86132E-08	1.44769E-08	1.86132E-08	3.30901E-08	8.17223E-95	30,220,542
17	10	2.95625E+17	3,730,428,685	1.77E+17	1.26188E-08	2.10313E-08	1.26188E-08	2.10313E-08	3.36501E-08	8.03622E-95	29,717,597
18	11	3.25188E+17	3,499,233,709	1.48E+17	1.07607E-08	2.36735E-08	1.07607E-08	2.36735E-08	3.44341E-08	7.85325E-95	29,040,956
19	12	3.5475E+17	3,158,177,307	1.18E+17	8.90254E-09	2.67076E-08	8.90254E-09	2.67076E-08	3.56102E-08	7.59389E-95	28,081,862
20	13	3.84313E+17	2,707,259,478	8.87E+16	7.04442E-09	3.05258E-08	7.04442E-09	3.05258E-08	3.75703E-08	7.19771E-95	26,616,804
21	14	4.13875E+17	2,146,480,223	5.91E+16	5.1863E-09	3.63041E-08	5.1863E-09	3.63041E-08	4.14904E-08	6.51764E-95	24,101,957
22	15	4.43438E+17	1,475,839,542	2.96E+16	3.32818E-09	4.99227E-08	3.32818E-09	4.99227E-08	5.32509E-08	5.07822E-95	18,779,036
23	15.9	4.70044E+17	778,331,409	2.96E+15	1.65587E-09	2.63283E-07	1.65587E-09	2.63283E-07	2.64939E-07	1.02069E-95	3,774,451
24	15.99	4.72704E+17	703,686,269	2.96E+14	1.48864E-09	2.38033E-06	1.48864E-09	2.38033E-06	2.38182E-06	1.13535E-96	419,847
25	15.999	4.7297E+17	696,172,812	2.96E+13	1.47192E-09	2.35492E-05	1.47192E-09	2.35492E-05	2.35507E-05	1.14825E-97	42,462
26	15.9999	4.72997E+17	695,420,977	2.96E+12	1.47024E-09	0.000235238	1.47024E-09	0.000235238	0.000235239	1.14955E-98	4,251
27	16	4.73E+17	695,337,434	0	1.47006E-09			0	1.570796	2.7042E-102	1
28			Coefficient **a** = - 6.2854 · 10-26 resulted in the bending of the outer geodesic to equal the radius of our Sun, such that the outer geodesic intersects the surface of the Sun.								
29	SPREADSHEET #4B		Note the decrease in the number of possible interaction sites as the beam approaches star B.						equals π/2		
30	Location of file: This PC/Documents/Amplification Effect of Gravitons/Spreadsheet #4 Outer Geodesic										

The apparent decrease of possible interaction sites at the very end of the geodesic is due to c being set equal to the radius of our Sun. Light blue highlighted area.

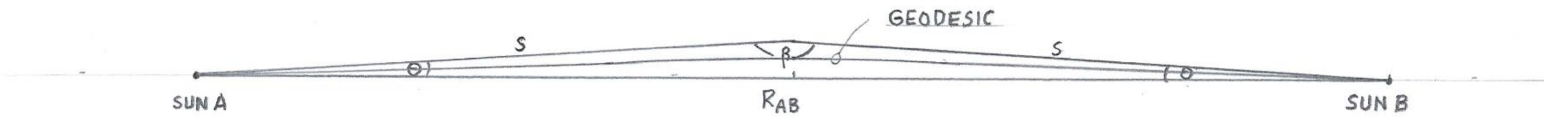

GEODESIC
S
S
β
SUN A
R_AB
SUN B

Fig. 7

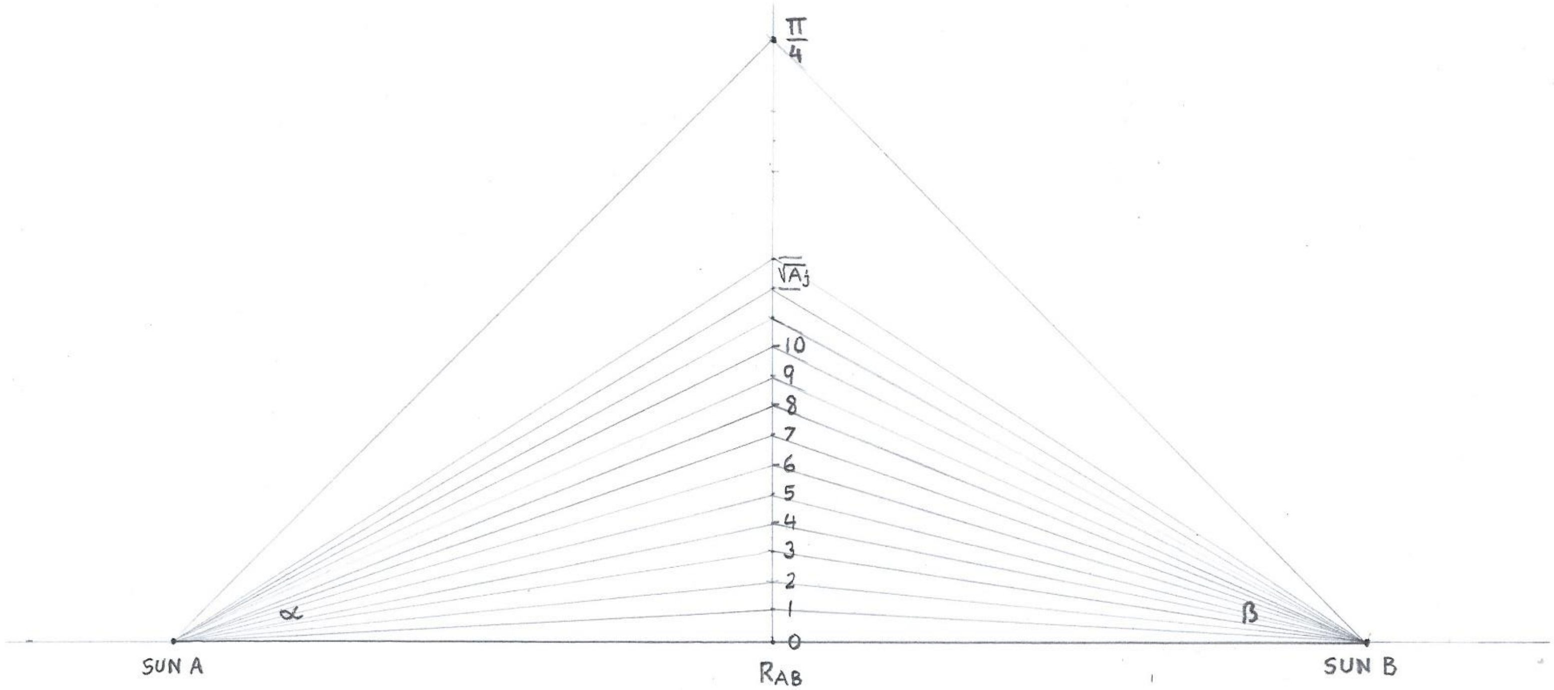

π/4
√A_j
10
9
8
7
6
5
4
3
2
1
0
α
β
SUN A
R_AB
SUN B

Fig. 8

DETERMINING THE AREA OF INTERSECTION FORMULA

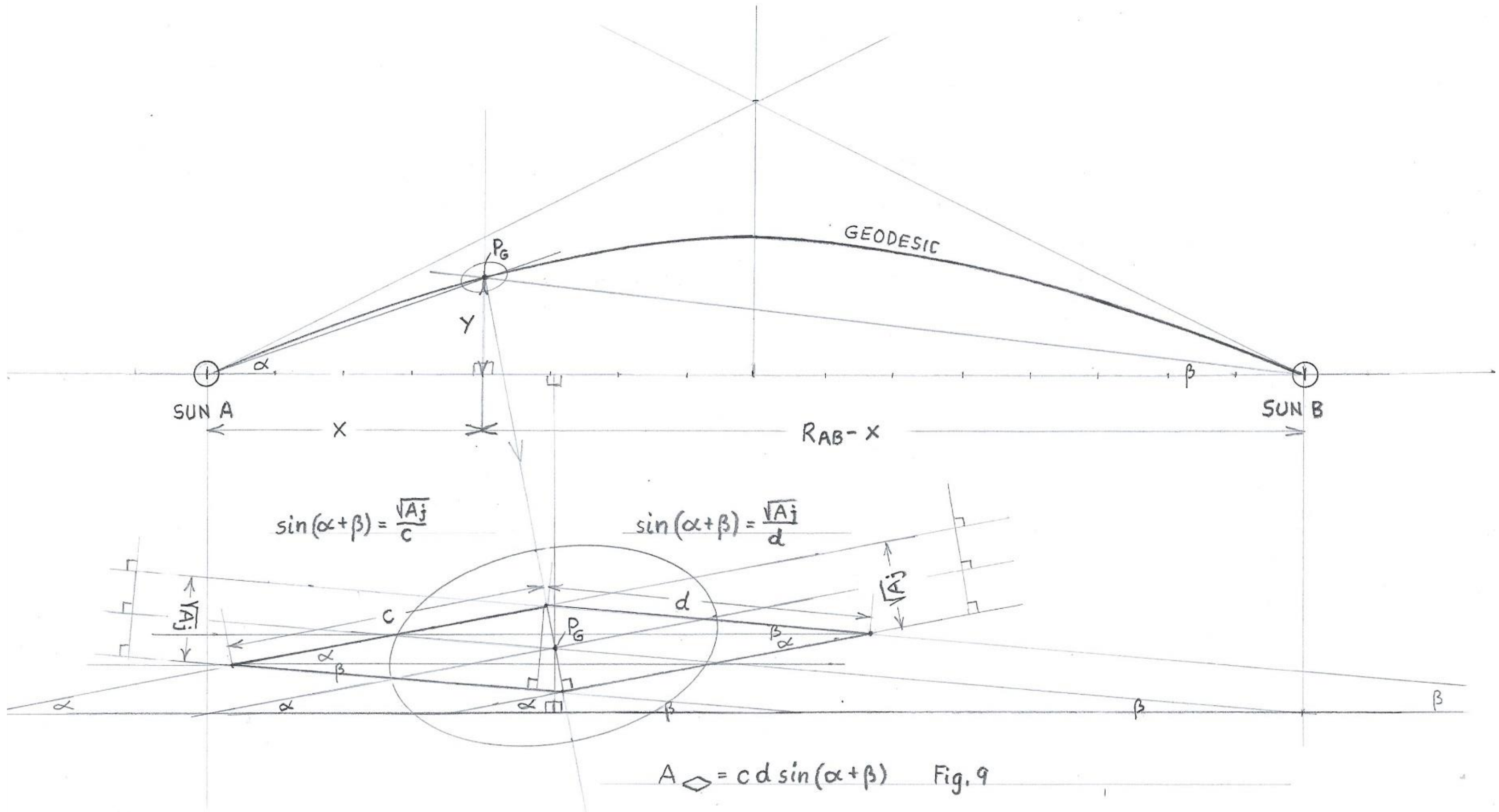


Fig. 9

KURT BECKER
11-28-2020

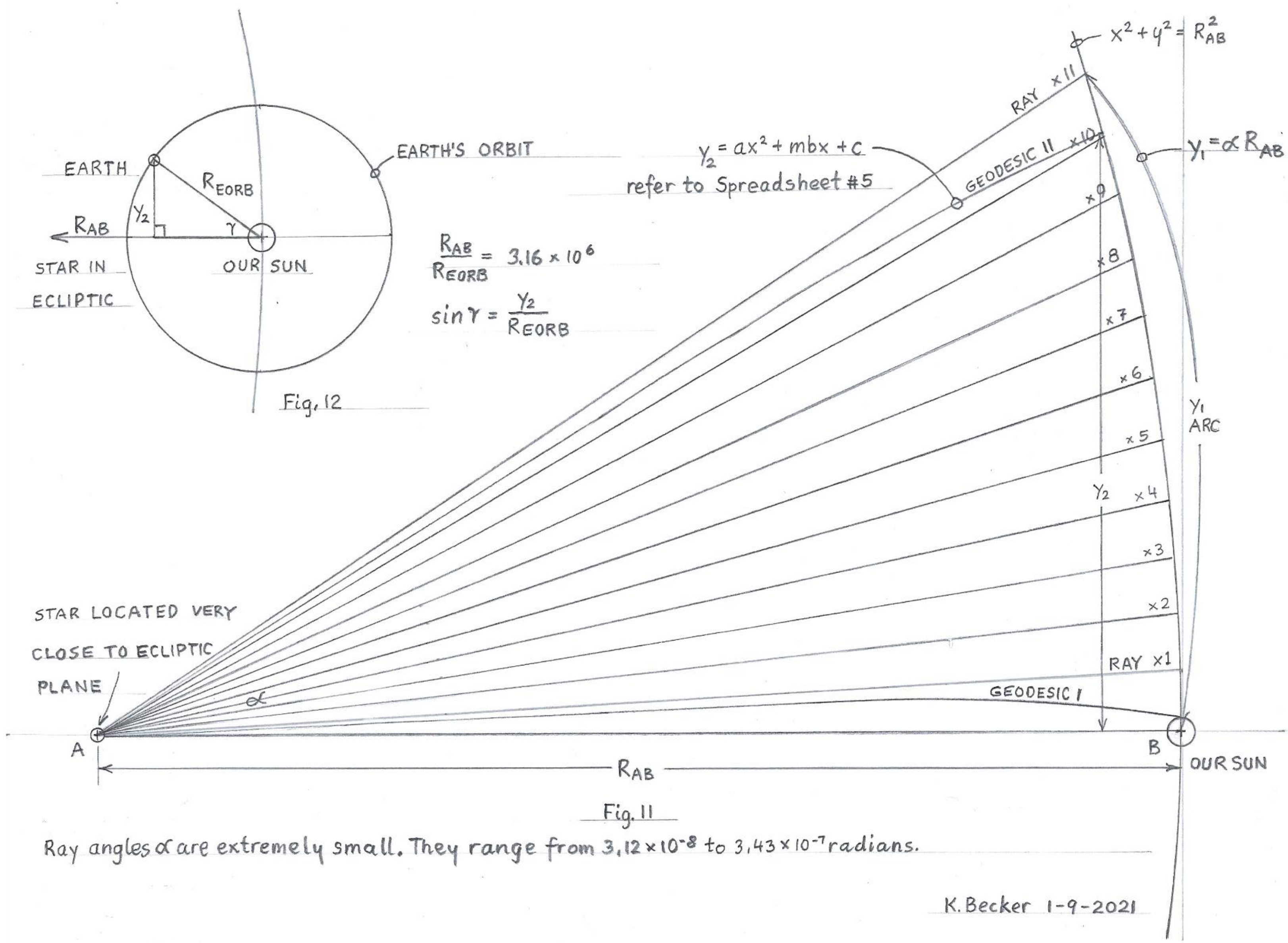


Fig. 12

Fig. 11

Ray angles α are extremely small. They range from 3.12×10^{-8} to 3.43×10^{-7} radians.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Spreadsheet #7-n1**	**The calculations assume that stars lie on the ecliptic plane, that is β = 0.**											
2	**Name of Star and beta off the ecliptic Ref. 8**	**R_{AB} = ly x 9.46 x10^{15} m**	**b (initial slope) = (r_{RB} - r_{SB})/R_{AB}**	**a = -b/x**	**x_M = 1/2 R_{AB}**	**y_M = 1/2(r_{RB} - r_{SB})**	$sin(\alpha) = \frac{y}{\sqrt{x^2+y^2}}$	$\cos(\alpha) = \frac{x}{\sqrt{x^2+y^2}}$	$\sin(\beta) = \frac{y}{\sqrt{(R_{AB}-x)^2+y^2}}$	$\cos(\beta) = \frac{R_{AB}-x}{\sqrt{(R_{AB}-x)^2+y^2}}$	**sin(α+β) = sin(α) cos(β) + sin(β) cos(α)**	$y_G = a\left(\frac{\sin(\alpha+\beta)}{\sin(\gamma+\delta)}\right)x^2 + bx$	$\Delta B = \frac{a_M}{a_N} + 1$
3	Beta in degress	R_{AB} distance between star and our Sun	from spreadsheet #2 column E	a is coefficient of x^2 (a results in the bending of the geodesic)	middle point on geodesic	middle point on geodesic	α and β above are angles shown in Fig. 9, determining the area of intersection formula				The result will be uced as a reference	For the basic geodesic, sin(α+β)/sin(γ+δ)=1	Change in annual brightness from spreadsheet #1, column I
4	Alpha Leonis β=+0.466°, 79 ly	7.4734E+17	2.0209E-08	-2.7042E-26	3.7367E+17	7.551600E+09	2.0209E-08	1.0000E+00	2.0209E-08	1.0000E+00	4.0419E-08	0.0000E+00	366
5	Delta Cancri β=+0.0793°, 180 ly	1.7028E+18	1.6717E-08	-9.8176E-27	8.5140E+17	1.423320E+10	1.6717E-08	1.0000E+00	1.6717E-08	1.0000E+00	3.3435E-08	0.0000E+00	1,240
6	Kappa Librae β=-0.0216°, 310 ly	2.9326E+18	1.7491E-08	-5.9645E-27	1.4663E+18	2.564760E+10	1.7491E-08	1.0000E+00	1.7491E-08	1.0000E+00	3.4983E-08	0.0000E+00	3,940
7													
8													
9	1 arc min at 1k ly	9.46E+18	8.2402E-09	-8.7105E-28	4.7300E+18	3.897600E+10	8.2402E-09	1.0000E+00	8.2402E-09	1.0000E+00	1.6480E-08	0.0000E+00	8,996
10	1 arc sec at 2K ly	1.892E+19	5.8123E-09	-3.072E-28	9.4600E+18	5.498400E+10	5.8123E-09	1.0000E+00	5.8123E-09	1.0000E+00	1.1625E-08	0.0000E+00	17,991
11	500 milli arc sec 3K ly	2.838E+19	4.7577E-09	-1.6764E-28	1.4190E+19	6.751200E+10	4.7577E-09	1.0000E+00	4.7577E-09	1.0000E+00	9.5154E-09	0.0000E+00	26,985
12	100 milli arc sec 4K ly	3.784E+19	4.1385E-09	-1.0937E-28	1.8920E+19	7.830000E+10	4.1385E-09	1.0000E+00	4.1385E-09	1.0000E+00	8.2770E-09	0.0000E+00	35,980
13	50 milli arc sec 5K ly	4.73E+19	3.6934E-09	-7.8084E-29	2.3650E+19	8.734800E+10	3.6934E-09	1.0000E+00	3.6934E-09	1.0000E+00	7.3867E-09	0.0000E+00	44,975
14	10 milli arc sec 5K ly	4.73E+19	3.6934E-09	-7.8084E-29	2.3650E+19	8.734800E+10	3.6934E-09	1.0000E+00	3.6934E-09	1.0000E+00	7.3867E-09	0.0000E+00	44,975
15	1 milli arc sec at 5K ly	4.73E+19	3.6934E-09	-7.8084E-29	2.3650E+19	8.734800E+10	3.6934E-09	1.0000E+00	3.6934E-09	1.0000E+00	7.3867E-09	0.0000E+00	44,975
16													
17	6.96E+10	Radius of our Sun in m											
18													
19	c = 0 (y-intercept) to simplify quadaratic equation.												
20	**The above calculations assume that stars lie on the ecliptic plane, that is β = 0.**												
21	**The calculations in spreadsheet #7-n2 use the actual β in radians of the particular star.**												

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Spreadsheet #7-n2**		**β used in calculations are shown in column A**													
2	**Name of Star and beta off the ecliptic Ref. 8**	**deg x π/180**	**R_{AB} = ly x 9.46 x10^{15} m**	**b = tan(β)**	a is from spreadsheet #7-n1, column D, for relevant star	**x_M = 1/2 R_{AB}**	**y_M = 1/2 tanβ R_{AB}**	$sin(\gamma) = \frac{y}{\sqrt{x^2+y^2}}$	$\cos(\gamma) = \frac{x}{\sqrt{x^2+y^2}}$	$\sin(\delta) = \frac{y}{\sqrt{(R_{AB}-x)^2+y^2}}$	$\cos(\delta) = \frac{R_{AB}-x}{\sqrt{(R_{AB}-x)^2+y^2}}$	**sin(γ+δ) = sin(γ) cos(δ) + sin(δ) cos(γ)**	$\frac{sin(\alpha+\beta)}{\sin(\gamma+\delta)}$	$y_G = a\left(\frac{\sin(\alpha+\beta)}{\sin(\gamma+\delta)}\right)x^2 + bx$	**yE = tan(β) RAB**	$\Delta B = \frac{y_E^2}{y_G^2}$
3	Beta in degress and stellar distance in light years	Beta in radians	R_{AB} distance between star and our Sun	Initial slope	a is coefficient of x^2 (is the bending of the geodesic)	above middle point on geodesic	above middle point on geodesic							at x = R_{AB}		Change in Brightness
4	Alpha Leonis β=+0.466° 79 ly	8.133234E-03	7.4734E+17	8.1334E-03	-2.7042E-26	3.7367E+17	3.0392E+15	8.1331E-03	9.9997E-01	8.1331E-03	9.9997E-01	1.6266E-02	2.4849E-06	6.078425361265E+15	6.078425361302E+15	1.000000000012E+00
5	Delta Cancri β=+0.0793° 180 ly	1.384046E-03	1.7028E+18	1.3840E-03	-9.8176E-27	8.5140E+17	1.1784E+15	1.3840E-03	1.0000E+00	1.3840E-03	1.0000E+00	2.7681E-03	1.2079E-05	2.356755198195E+15	2.356755198539E+15	1.000000000292E+00
6	Kappa Librae β=-0.0216° 310 ly	-1.130973E-03	2.9326E+18	-1.1310E-03	-5.9645E-27	1.4663E+18	-1.6583E+15	-1.1310E-03	1.0000E+00	-1.1310E-03	1.0000E+00	-2.2619E-03	-1.5466E-05	-3.316693875066E+15	-3.316693875859E+15	1.000000000478E+00
7																Change in brightness is too small to be observed from Earth.
8	β = 1 arc minute at 1K ly	2.908882E-04	9.4600E+18	2.9089E-04	-8.7105E-28	4.7300E+18	1.3759E+15	2.9089E-04	1.0000E+00	2.9089E-04	1.0000E+00	5.8178E-04	2.8327E-05	2.751802529385E+15	2.751802531593E+15	1.000000001605E+00
9	β = 1 arc second at 2K ly	4.848137E-06	1.8920E+19	4.8481E-06	-3.0720E-28	9.4600E+18	4.5863E+13	4.8481E-06	1.0000E+00	4.8481E-06	1.0000E+00	9.6963E-06	1.1989E-03	9.172661662531E+13	9.172674846664E+13	1.000002874660E+00
10	β = 500 milli arc sec at 3K ly	2.424068E-06	2.8380E+19	2.4241E-06	-1.6764E-28	1.4190E+19	3.4398E+13	2.4241E-06	1.0000E+00	2.4241E-06	1.0000E+00	4.8481E-06	2.3978E-03	6.879473759156E+13	6.879506134958E+13	1.000009412312E+00
11	β = 100 milli arc sec at 4K ly	4.848137E-07	3.7840E+19	4.8481E-07	-1.0937E-28	1.8920E+19	9.1727E+12	4.8481E-07	1.0000E+00	4.8481E-07	1.0000E+00	9.6963E-07	1.1989E-02	1.834347215592E+13	1.834534969319E+13	1.000204719514E+00
12	β = 50 milli arc sec at 5K ly	2.424068E-07	4.7300E+19	2.4241E-07	-7.8084E-29	2.3650E+19	5.7329E+12	2.4241E-07	1.0000E+00	2.4241E-07	1.0000E+00	4.8481E-07	2.3978E-02	1.146165463474E+13	1.146584355824E+13	1.000731079255E+00
13	β = 10 milli arc sec at 5K ly	4.848137E-08	4.7300E+19	4.8481E-08	-7.8084E-29	2.3650E+19	1.1466E+12	4.8481E-08	1.0000E+00	4.8481E-08	1.0000E+00	9.6963E-08	1.1989E-01	2.272224094156E+12	2.293168711648E+12	1.018520310438E+00
14	β = 1 milli arc sec at 5K ly	4.848137E-09	4.7300E+19	4.8481E-09	-7.8084E-29	2.3650E+19	1.1466E+11	4.8481E-09	1.0000E+00	4.8481E-09	1.0000E+00	9.6963E-09	7.6181E-01	9.623161866489E+10	2.293168711648E+11	5.678536652369E+00
15											Cells highlighted in yellow show substantial changes in brightness at angles of only 10 and 1 milli arc seconds.					
16																

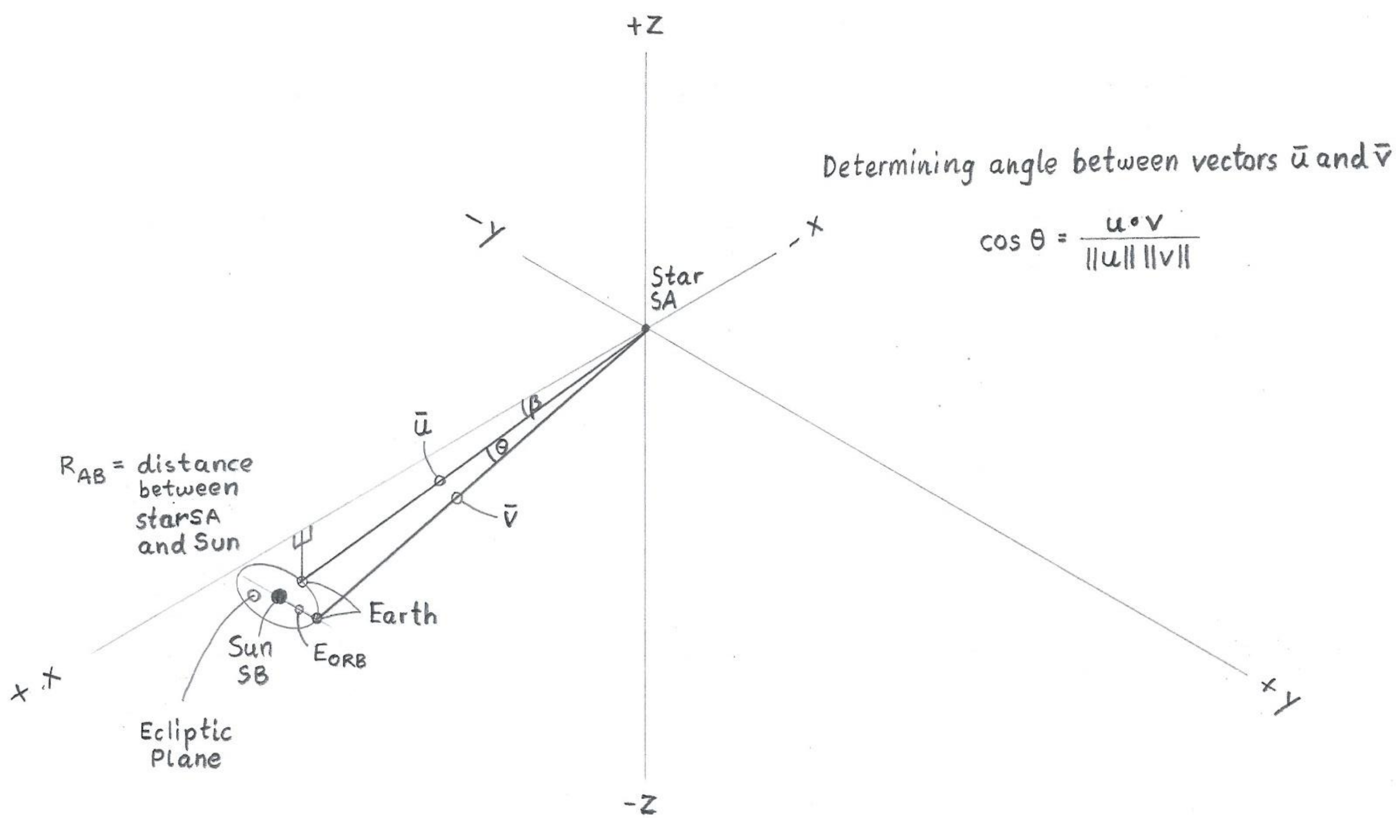


Fig. 14

K.Becker 4-18-2021

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Spreadsheet #8-n1**											
2								$cos\,\theta = \frac{\boldsymbol{u} \cdot \boldsymbol{v}}{\lVert \boldsymbol{u} \rVert \lVert \boldsymbol{v} \rVert}$				
3	Constants	R_{AB} in m	4.73E+19	E_{ORB} in m	1.49600000E+11	1 milli arc sec in radians	4.8481E-09	**dot product u * v**	$\lVert \boldsymbol{u} \rVert$	$\lVert \boldsymbol{v} \rVert$	$cos\,\theta = \frac{\boldsymbol{u} \cdot \boldsymbol{v}}{\lVert \boldsymbol{u} \rVert \lVert \boldsymbol{v} \rVert}$	**$\cos \theta^{-1}$**
4	vector u	Ux	4.7299999850E+19	Uy	0.00E+00	Uz	-2.2931512927E+11	2.2372899929E+39	4.7299999850E+19	4.7300000000E+19	1.0000000000E+00	0.000000000000E+00
5	vector v	Vx	4.73E+19	Vy	1.4960000000E+11	Vz	-2.2931513000E+11					
6												
7	Vectors **u** and **v** are 3 months apart in the Earth's orbit. The angle between u and v is between mathematical zero and zero to 12 digits.											

Observational Test of Hypothesis:

How can the compression of geodesics between distant stars be measured and viewed? The photons will follow the geodesics. When light from the distant star is viewed along a line very closely parallel to the line-of-centers between these two stars, the star will appear much brighter as when viewed just a few arc seconds off the line-of-centers. The bending of space-time within a narrow beam between these two stars can be measured by the change in brightness of the distant star. Please look at the rightmost column of spreadsheet #1.

Refer to spreadsheet #7-n2, column P, and spreadsheet #8-n1, column L. Since the angle between the vectors u and v is 0.000000000000, to 12 digits, there will be now change in brightness of the star due to the Earth orbiting around our Sun. Therefore, even if a distant star is found that lies only 1 milli-arc sec above the ecliptic plane, no change in brightness can be detected as viewed through a telescope on Earth. **The change in brightness can only be viewed through a telescope in space due to atmospheric turbulence and extremely close angular alignment requirements.** In addition, a telescope with a very large diameter will be needed.

The telescope needs to be located in the cylinder between the star and our Sun, which is easy to achieve, and needs to be aligned with the line of centers between the two stars by less than 1 milli arc sec, which a much more difficult to achieve. The best spot to observe the large change in brightness is 0.85 radius off center of the cylinder. As spreadsheet #1, column I. shows, the increase in brightness will be very large, depending on distance and mass of the star. (It is highly unlikely that the above measurements will ever be undertaken.)

At first glance, the idea of self-magnifying beams of gravity my seem strange, but then matter also self-assembles into stars and planets. Furthermore, the clumping of matter does not violate the second law of thermodynamics. This brings up another test of the hypothesis posited in this paper: Does it violate the second law and increase entropy overall? The self-compression of geodesics will decrease entropy, but then the vast majority of radiating gravitational vectors interacting with countless other gravitational vectors at larger angles (above 1 arc minute) will greatly increase entropy. Look at spreadsheet #4B, column K. The number of possible interaction sites quickly decease as the angle of intersection increases; cells highlighted in light blue. Statistically, gravitational field self-interactions will result in random bending of geodesics, that is, it will increase entropy.

Summary:

Newton's Law of Universal Gravitation does not take into account the interactions of nearly parallel gravitational vectors between stars. This paper has explored a physical process which may focuses geodesics between two distant stars. Although there is no universally accepted theory of quantum gravity, Loop Quantum Gravity was selected as its basis. The beam of space-time between two distant stars has a very special geometry in that the self-interactions of space always result in radially bending the geodesics toward the line-of-centers between the two stars. This bends adjacent geodesics, which would have missed the disks of these two stars, to intersect their disks. For stars separated by many light years, this will substantially increase gravity between these two stars. It is important to note that the bending of geodesics rapidly deceases as the angle only very slightly increases.

This paper models only increases in gravity between two stars, that is, there are no other stars close by, such as in multi-star systems or star clusters. Then the model becomes more complex.

The mathematical model proposed here is based on the minimum areas and volumes of the spectrum of spin networks, as posited by Loop Quantum gravity. If observations confirm this hypothesis, it will also tend to confirm the granularity of space and its smallest sizes. The MOND constant a_0 may be directly calculated from observations.

My language and geometric methods in this paper may not be aligned with how nature actually works and with how physicists mathematically describe space-time. The main hypothesis is: Space-time between stars self-amplifies to increase gravity between stars as MOND equations empirically predict. I have proposed a testable astronomic observation, the increase in brightness of a star when it is viewed very, very closely aligned along the line-of-centers.

If the hypothesis is verified by observation, how will it affect the gravitational binding of stars on a galactic scale? Each star will be attracted by gravitational beams from all other stars.

How will the gravitational model of our galaxy change? It will now depend on the added gravity of the myriad gravitational flux tubes, as quantified by MOND's empirical equation and constant a_0.

How will astronomy change? Since the brightness of distant stars increases greatly when viewed from the line-of-centers, space-based stellar observations will greatly improve. **Gravitation between distant stars and our Sun can be directly measured by comparing the change in brightness between on-beam and off-beam.**

References:

Ref. 1 Physics textbook, second edition, Hans Ohanian, page 212; I. Newton, Mathematical Principles of Natural Philosophy, 1687.

Ref. 2 M. Milgrom, arXiv:1404.7661v2 Astrophysics. 31 Aug 2014, Title: MOND theory

Ref. 3 R. Scarpa, Modified Newtonian Dynamics, an Introductory Review, European Southern Observatory

Ref. 4 A. Deur, professor at the University of Virginia; aeXiv:09014005v2 Astrophysics. Title: "Implications of Graviton-Graviton Interaction to Dark Matter."

Ref. 5 C. Rovelli, arXiv:gr-gc9710008v1 General Relativity and Quantum Cosmology. 1 Oct 1997, Title: Loop Quantum Gravity

Ref. 6 The book: "*Reality is Not What it Seems*, The Journey to Quantum Gravity"; by Carlo Rovelli; pages 148, 166, 186, 193, Riverhead Books; ISBN 9780735213920

The above book is at an undergraduate level.

Ref. 7 C. Rovelli and Francesca Vidotto, The book: "*Covariant Loop Quantum Gravity*, An Elementary Introduction to Quantum Gravity and Spinfoam Theory"; Cambridge University Press, ISBN 9781107069626

The above book is not elementary. It is at a post- graduate level.

Ref. 8 List of stars on the Ecliptic star map, Sky Publishing Corp., 49 Bay State Road, Cambridge, Mass. 02138

Location and name of file: This PC>Windows-SSD(C:)>Users>Owner>Documents>Amplification Effect of Gravitons>A Model of a Gravitational Flux Tube between Two Stars.