the general science journal

The Solar Wobble or Gravity, Rosettes and Inertia

john.erich.ebner@gmail.com

http:blackholeformulas.com

February 10, 2015

Abstract

Our objective is to show that the sun moves. At least it wobbles. Any star with planets, orbits with its planets. The sun moves so it is far from being the unmoving center of the solar system. We show a new way to sum the gravitational forces of the planets to calculate the solar orbit and its wobble. You see the wobble of the sun is caused by the much smaller masses of the planets. When the planets move they drag the sun with them. When the sun moves it drags the planets with it. You see that any object which experiences a force, that is accelerated, is resisted by the masses of the planets, by the mass of the sun and the mass of the Cosmos. The wobbly orbit of the sun is evidence that this is inertia.

Key Words

Orbits, binary systems, rosettes, orbital lobes, solar wobble, stellar wobble, cosmic wobble, gravity, inertia, origin of inertia

Contents

List of Figures

Authors Note

This document was written with Latex http://latex-project.org/ftp.html and TexStudio http://texstudio.sourceforge.net/, both of which are excellent, open-source and free. The PDF pages it produces can be read in two page view and printed two pages at a time in landscape to save paper or make a book.

1 Introduction

The sun and planets are a balanced dynamic unit. The planets trace out large concentric circles while the sun, because of its huge mass, traces out small circles. The small orbits of the sun appear as wobbles. We rarely hear about the wobble of the sun because the sun orbits in the plane of planets where we look at the sun's equator. The movement of the sun would be most visible when looking down on the sun's poles. First, we will look at the sun and earth as a binary system. They orbit around their common center of gravity, bc, the barycenter.

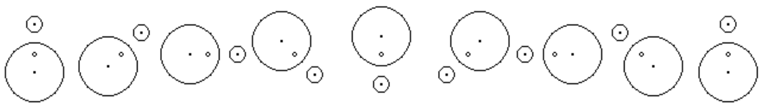

Figure 1: Binary system

2 Wobbles and a donut

When the barycenter is inside a member of a binary system, as it is figure (1), then its motion is a wobble. See the animation [1]. The earth appears to wobble because of the Moon when seen perpendicular to the earth-moon plane. The sun appears to wobble, because of its planets, when seen from its poles. We see the sun from its equator where we can't see the wobbles directly but we might detect the doppler-shift in the sun's light caused by these wobbles. Wobbles can also reveal planets around other stars by the doppler-shift in their stars light which are most pronounced when seen from their equator or planetary plane edge-on.

There is a different barycenter and wobble in the sun for each planet. Galaxies wobble. The universe wobbles. The sun orbits about all of its different centers of mass of all the planets simultaneously. This is a complex pattern of movement.

Only the sun-Jupiter barycenter is outside the surface of the sun. The sun makes offset from its center orbits or wobbles around its barycenter for all the planets except for Jupiter. The wobbles have the orbital period of the planets. The sun makes a donut, not a wobble, in its orbit with Jupiter. This barycenter is outside the radius of the sun. The donut has the orbital period of Jupiter. The donut is seen from the solar poles against the background of the fixed stars. If the sun and Jupiter orbit around their common barycenter then in some real way the earth orbits with Jupiter. In what way?

3 Barycenter distance from the sun's center

Planet	Barycenter	m	Angle
Mercury	9606	m	5.74054
Venus	264923	m	4.94436
Earth	449776	m	2.97685
Mars	73560	m	2.08145
Jupiter	742764579	m	2.51852
Saturn	408109998	m	1.50738
Uranus	125285030	m	1.18698
Neptune	230608687	m	3.19058
Pluto	38350	m	2.22995

When we sum the forces of gravity of all the planets in the solar system, we see the sun has a complex orbit and some of the planetary orbits have lobes. These wobbles and lobes are missed when you consider the sun to be the unmoving center of our solar system.

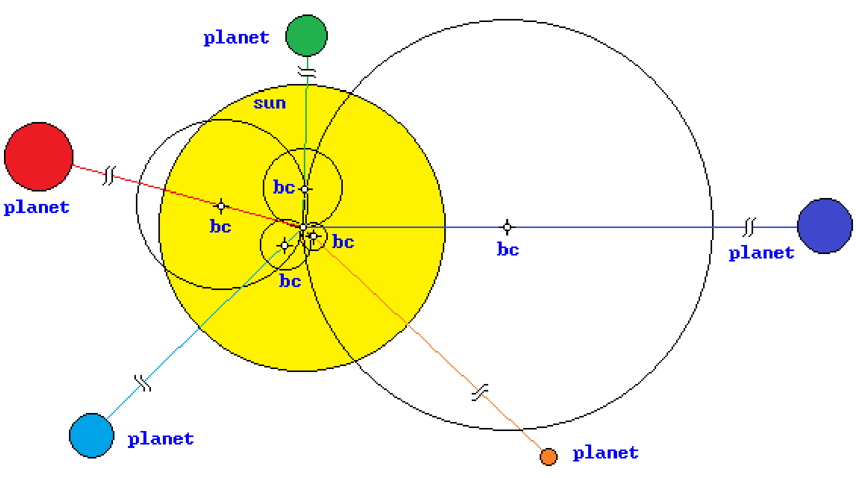

Figure 2: The center of the sun orbits or rolls around the circles of each of the planetary barycenters, bc, as the planets orbit their bc. Inserting a pin in any bc, you can rotate the figure, get the idea and see the wobbles. The entire solar system spins around

each different bc. The location and radius of the barycenters are the same but shown a little larger on the figure below.

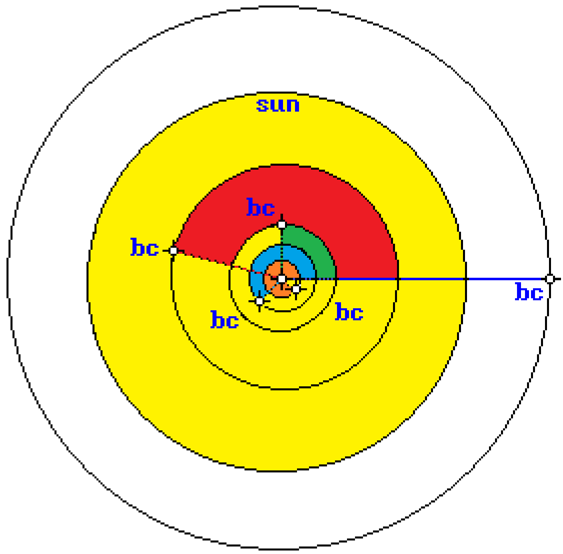

Figure 3: The location and radius of the barycenters are the same as figure (2) above. Inserting a pin in any bc, you can rotate the figure, get the idea and see the wobbles. It is easy to see the sine and cosine components of the planetary vectors. The sines and cosines may be summed to find the location and forces on the sun as is shown on figure (8).

4 Kepler's third law

$$\frac{m * vt^2}{r} = \frac{G * m * M}{r^2} \tag{4.1}$$

Centrifugal force equals gravitational force or centrifugal force equals centripetal force. This is just another way of writing Kepler's third law. M and m are mass. vt is tangent velocity. G is the gravitational constant. r is the distance between the masses. The period of a circular orbit is p.

$$p = \frac{2\pi r}{vt} \quad therefore \quad vt^2 = \frac{4\pi^2 r^2}{p^2}$$

Substitute for vt^2 and collect terms.

$$4\pi^2 r^3 = p^2 GM \tag{4.2}$$

The cube of the radius is proportional to the square of the period. This is Kepler's third law but we will usually use it in the centrifugal force equals the gravitational force form. This equation and the idea of conservation of energy are both indubitably correct and are central to our arguments.

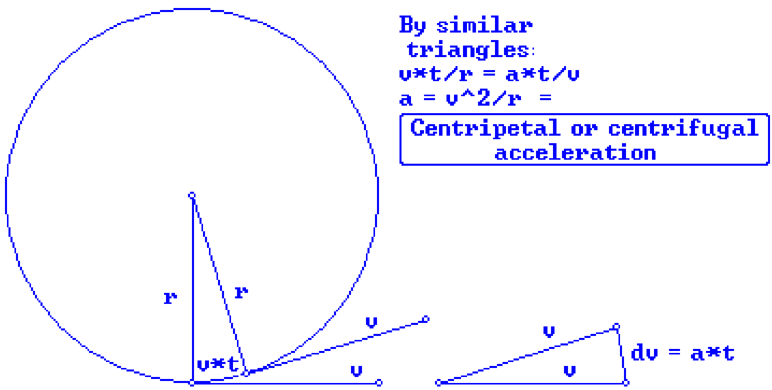

Figure 4: Centrifugal Force by Similar Triangles

When gravity exerts a center seeking centripetal force, inertia opposes this deviation from straight line motion with a center fleeing centrifugal force. The centripetal gravitational force equals the inertial centrifugal force along a circular orbital path. For every action there is an equal but opposite reaction.

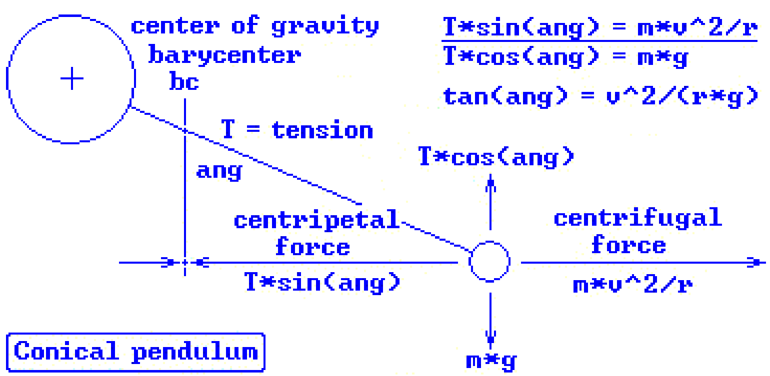

Figure 5: Conical Pendulum Forces

A conical pendulum or a weight on a string is held out in its orbit by centrifugal force. Slinging a rock on a rope, around in a circle, demonstrates this centrifugal force which can easily be measured with a spring scale used by fishermen. You and the rock are masses in a binary system, in orbit across from each other around a common center of mass with a common orbital period. The center of mass or barycenter is always someplace along the rope between you and the rock. The centrifugal forces are with respect to the barycenter, the center of gravity, not the distance between the masses.

Your centrifugal force at your distance from the barycenter equals the centrifugal force of the rock at its distance from the common barycenter equals the tension in the rope between the two masses times the sine of the angle.

If the rope is cut or released both the centripetal and centrifugal forces become zero. The rock continues on its inertial path. You continue on your inertial path determined by your momentum prior to release, that is, tangent to the circle at the point of release. The two paths are in opposite directions.

Reality is defined by simple experiments like this one. I suspect Newton would have done something like this experiment when he was in his twenties working on gravitation in the sixteen sixties. He would have known this is equivalent to Kepler's third law.

5 Orbits

Orbits are so intertwined with centrifugal force that they are usually inseparable. When something moves in a circular orbit, satellites around the earth, planets around the sun, electrons around protons, light around black holes, the centrifugal force equals the centriptal force. The centrifugal force equals the gravitational force of attraction or the centrifugal force equals the electrostatic force of attraction. The repulsive centrifugal force between two orbiting bodies which tries to pull them apart has to be equal, at some points in their orbit, to the attractive centripetal force which tries to pull the two bodies together, or the bodies can not orbit. If the repulsive centrifugal force is greater than the attractive force then the bodies will drift apart. If the centrifugal force is less than the attractive centripetal force then the bodies will drift together. Only the equality, the equilibrium state between the attractive and repulsive forces between the two masses can endure. The evidence of equilibrium is the orbit. The bodies drift apart with a constant velocity in the expansion of the universe and drift apart or together with a variable velocity in elliptical orbits.

In the solar system each planet imposes an additional gravitational and centrifugal force, barycenter and orbital period on the sun. The angle and force between the sun and planets can be expressed as x, y and z forces, summed and applied to the sun so that the sun also moves. There are no unmoving centers. All the masses always move.

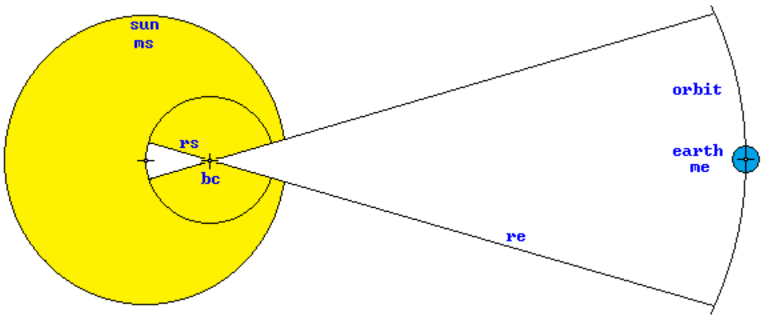

Figure 6: The earth and sun both orbit around, bc, the barycenter or the center of gravity of the pair. The path that the sun's center follows, the solar orbital path with respect to the earth, is shown as the black circle inside the sun. The center of the earth, bc, and the center of the sun are all in a line. The sun wobbles around bc like in figure (1). The earth and suns orbits around bc are like concentric circles.

6 Centrifugal force of the earth = Centrifugal force of the sun = Gravitational force

$$\frac{me * ve^2}{re} = \frac{ms * vs^2}{rs} = \frac{G * me * ms}{(re + rs)^2} = 3.54E22\ \frac{kg * m}{s^2} \tag{6.1}$$

When cd = re+rs = 149.6E9 m. See figure (6). This is the center distance which actually varies from perigee to apogee. G is the gravitational constant. me and ms are the masses of the earth and sun. re and rs are the distances to the barycenter. ve and vs are the earth and sun orbital velocities around, bc, the barycenter. If cd is greater than 149.6E9 m then the centrifugal force is greater than the gravitational force. If cd is less than 149.6E9 m then the gravitational force is greater than the centrifugal force. cd varies from
earth's perigee = 147.1E9 m to
earth's apogee = 152.1E9 m.

The left force of equation (6.1) is the centrifugal force of the earth around, bc, the earth-sun barycenter, the center of gravity.

The second force from the left on equation (6.1) is the centrifugal force of the sun as it also orbits, bc, the earth-sun barycenter. The sun also moves. This force is always neglected in over simplifications. Where is it not neglected? This force is necessary to understand inertia,
force = mass * acceleration.

The third force from the left on equation (6.1) is the gravitational force between the center of the earth and sun across the barycenter. The earth and sun both orbit at different distances about the same point with the same orbital period. That point is the barycenter of the earth-sun system. The three forces are along a line through the barycenter.

7 Ficticious Propagation delay

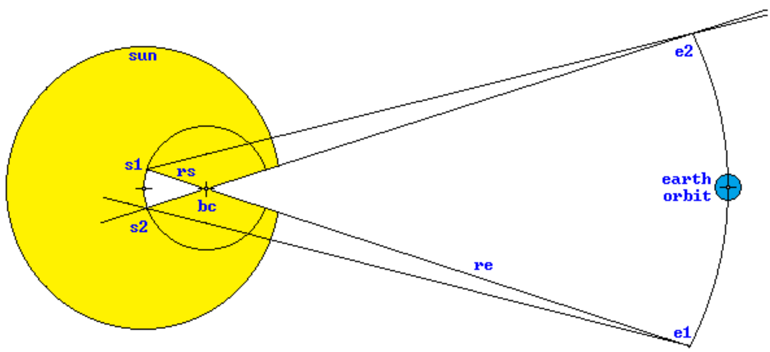

Figure 7: If the orbital forces had a propagation delay then, looking at figure (7), all the forces would not be in a line. The forces would pull on where the masses used to be and not where they are. The propagation delay, in this example, is the eight minutes that light takes to reach us from the sun. The movement of the earth from e1 to e2 or the sun from s1 to s2 takes eight minutes. The propagation along re+rs is eight minutes. The centrifugal force at e2 would be along the line bc-e2. The centrifugal force at s2 would be along the line bc-s2. Both repulsive centrifugal forces are along the line, s2-e2, so they are fine.
The gravitational force of the sun at s2 pulls on the earth at e1.
The gravitational force of the earth at e2 pulls on the sun at s1.
The angle between the centrifugal force and gravitational force at

s2, bc-s2-e1, is bigger than the angle at e2, bc-e2-s1. The angle at s2 is bigger than the angle at e2. The gravitational and centrifugal forces point in different directions. The forces would not be in a line. The forces would form couples. Energy would not be conserved. The orbits would not endure. See Van Flandern [3]. Only if there is no propagation delay are the forces along a line. When you pull something, the rope is straight. Since the force between orbiting bodies acts instantaneously, or nearly so, and the orbits have existed for billions of years, we assume there is no propagation delay.

Inertia is the reaction of the masses of the Cosmos to an acceleration. We will see that to explain inertia requires the entire mass of the universe. We assume that there is no propagation delay with inertia which would reduce the mass available for inertia.

8 Seeing the sun and earth as a orbiting binary system

We are using the earth and sun as an example. A binary system is defined by the variables of mass, distance to the barycenter, tangent velocity around the barycenter and center distance between the masses.

$$ms * vs = me * ve = 1.78E29\ \frac{kg * m}{s} \tag{8.1}$$

Their angular momentums are equal. This uses mass and orbital velocity.

$$ms * rs = me * re = 8.93E35\ kg * m \tag{8.2}$$

Their mass distance products are equal. This is the balance equation used in scales.

$$\frac{vs}{rs} = \frac{ve}{re} = 1.99E\neg 7\ \frac{1}{s} \tag{8.3}$$

This is equation (8.1) divided by (8.2). Their angular velocities and orbital periods are equal. The angular velocity in radians per second is the orbital velocity of the object divided by the distance to the barycenter. The angular velocity of the sun and earth and their orbital periods are the same since they are a binary system.
centrifugal force of the sun = centrifugal force of the earth

$$\frac{ms * vs^2}{rs} = \frac{me * ve^2}{re} = 3.54E22\ \frac{kg * m}{s^2} \tag{8.4}$$

this is equation (8.1) times (8.3). Their gravitational and centrifugal forces are equal.

9 Distance and velocity

We can calculate the distance to the barycenter of each of the bodies if we know their masses and their total distance apart. In all orbiting binary systems, the distance, velocity and mass are related by ratios and products. The elliptical orbit of the earth and sun have an eccentricity of e = 0.0167. The sun's ellipse and earth's ellipse share a common focus at the sun-earth barycenter and a common orbital period. When the earth is at perigee, the sun is at perigee on its much smaller ellipse. When the sun is at apogee, the earth is at apogee on its separate ellipse. The sun at rs and earth at re are opposite each other across the barycenter.
cd = re + rs = center distance. The center distance is the distance between the earth and the sun.

$$re + rs = cd = 149.6E9\ m \tag{9.1}$$

The distance between the bodies cd changes constantly in an elliptical orbit but not in a circular orbit. When cd changes re, rs, ve and vs and this group of equations also change. cd is here shown as the average distance, the au, only for convenience in working this example, since it should be emphasized that it is a distance which varies from perigee to apogee. An au, astronomical unit, is the unvarying average distance between the earth and the sun.

$$\frac{rs * ms}{me} + rs = cd \tag{9.2}$$

Substituted for re = rs*ms/me from equation (8.2).

$$\frac{rs * (ms + me)}{me} = cd \tag{9.3}$$

Collected terms.
me = 5.97E24 kg, the earth's mass.
ms = 1.99E30 kg, the sun's mass.

$$rs = \frac{cd * me}{ms + me} = \frac{149.6E9\ m * 5.97E24\ kg}{1.99E30\ kg + 5.97E24\ kg} = 449312\ m \tag{9.4}$$

The distance from the sun-earth barycenter to the center of the sun. The sun is not stationary. The sun orbits around the sun-earth barycenter at this distance from the center of the sun. The planetary data [4] shows this as the solar wobble distance. Each planet has a different cd and rs distance.
This is the offset from the solar center which the sun orbits around with respect to the earth. The solar radius is about 696E6 m so

this offset is about $\frac{1}{155}$ of the solar radius, quite close to the center of the sun. The earth by itself does not cause much of a wobble in the sun's orbit but with the action of all the planets there is a considerable wobble in the sun's orbit.

$$re = \frac{cd * ms}{ms + me} = 149.6E9\ m \tag{9.5}$$

$$ve = \frac{2\pi * re}{period} = \frac{2\pi * re}{31556926s} = 29.786\ \frac{km}{s} \tag{9.6}$$

The earth zips along. The earth's orbital period around the barycenter is one year as is the sun's with respect to the earth.

$$vs = \frac{ve * me}{ms} = \frac{ve * rs}{re} = 0.08955\ \frac{m}{s} \tag{9.7}$$

From (8.1) or (8.3). Galileo was wrong, the sun does move with respect to the earth, but not fast. The sun crawls along. This is 3.5 inches per second or 0.2 miles per hour.

10 Vector forces

The suns movement is the vector sum of the forces of the solar system and galactic and other forces from outside our solar system. The sun moves with respect to the background stars, galaxy and quasars as well as the planets. Figure (8) uses the radial angles and the forces of all the planets. The sun is also moved by many other forces from outside the solar system but none are included in these calculations. The rosettes which follow were calculated in this way. We use the fact that both the sun and planets move. When the planets move the sun moves.

1. The sum of the x, y, and z components of the radial gravitational forces of the planets, when divided by the mass of the sun is an acceleration of the sun.
2. The suns acceleration over time is a velocity in a certain direction.
3. The direction, velocity and location of the sun with respect to the background stars varies as the sun loops around.
4. These movements produce huge tidal forces in the sun. See figures (9) and (10). These tides may produce solar tsunamis.
5. The tides suck energy from the suns rotation. Over billions of years the sun has lost much of its angular velocity accounting for its slow rotation. The reason for the suns slow rotation is sometimes

called an unknown in physics. As the sun slows in its rotation, the sun recedes in its orbit, the planets recede in their orbits.

6. This is a solar system wide Hubble like expansion.

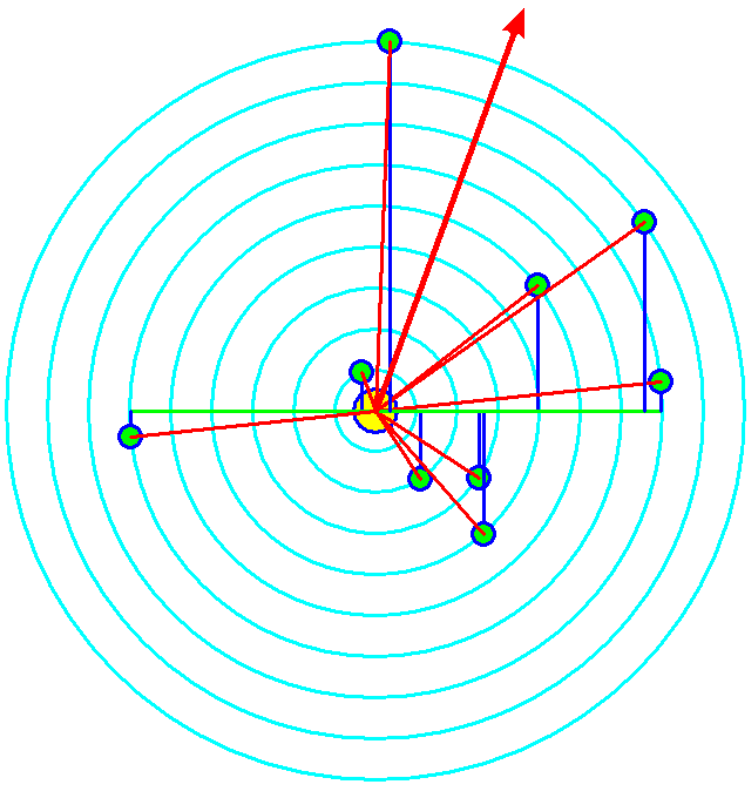

Figure 8: Planetary Vectors
Forces are vectors = red lines.
You can add the x, y and z components of vectors or forces.
x = radial force*cosine(angle) = green lines
y = radial force*sine(angle) = blue lines
The summation of the x and y planetary forces is the resultant force that the sun experiences from the planets. This resultant force causes the sun to move = large red arrow.

11 The Solar Wobble

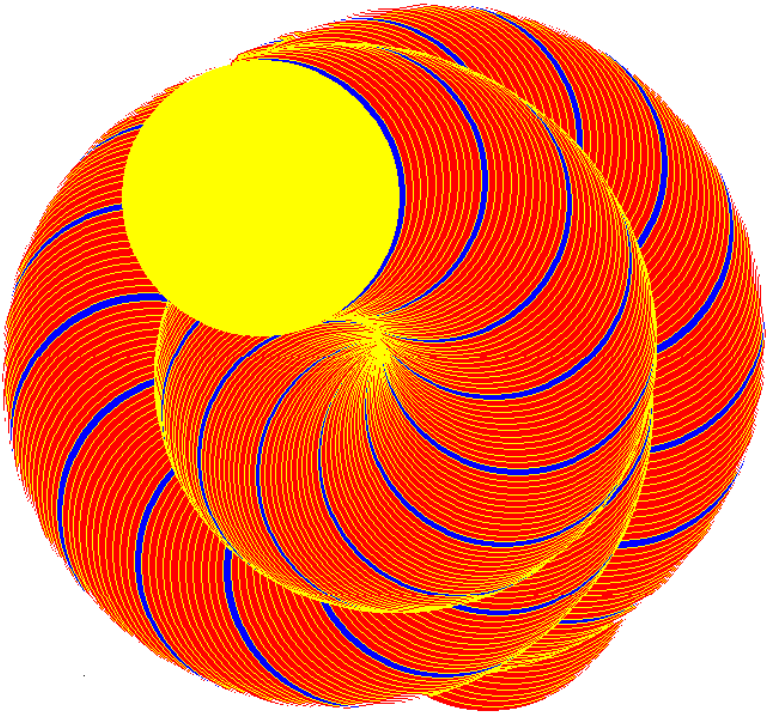

Figure 9: The sun's disk is shown as blue for a month per year from 1944 to 2020. This is a scale drawing of the solar disk and the movement of the sun. We see it again in following figure (10).

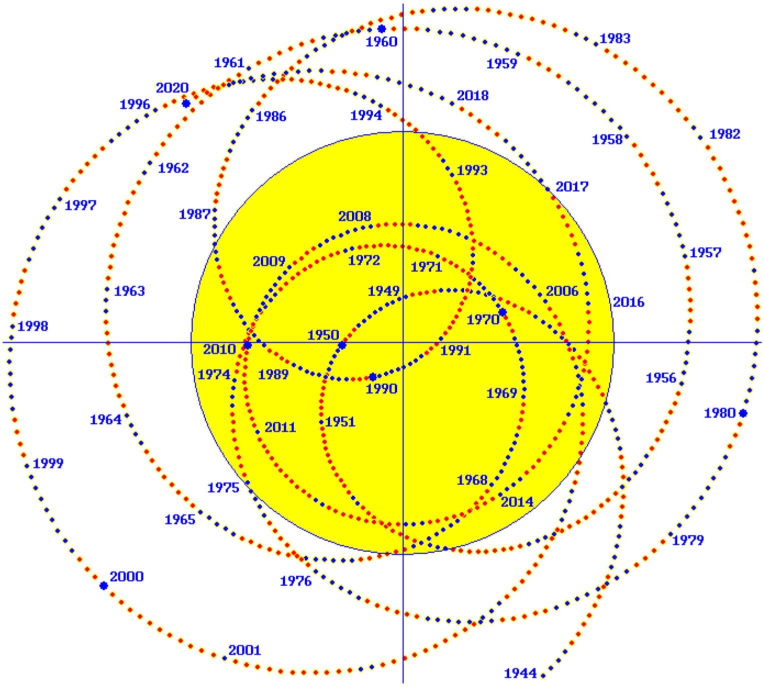

Figure 10: Here the path of the center of the sun is shown as a series of monthly dots from 1944 to 2020. These dots show the path of the center of the sun. The sun is seen to orbit around an average position with respect to the background stars where the yellow solar disk is drawn to scale. The sun's orbit has lobes like the planets. This figure approximates the start of the time period seen in the Wiki figure (11). The movements of the sun are similar in both figures for confirmation of our calculations. The suns orbit is obviously not circular or elliptical. This complex orbit is caused by the planets. The sun must experience huge tidal forces and friction losses to its angular momentum, to move like this.

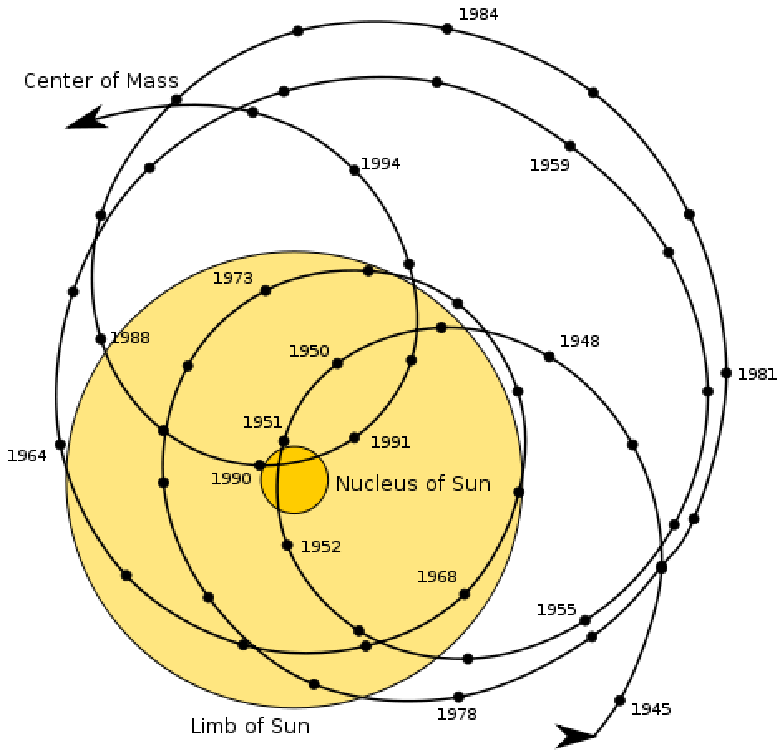

Figure 11: Wiki Solar System Barycenter [7]. The yellow disk is the size of the sun. The black line is the path and location of the sun from 1945 to 1995. See the "Barycenter in astrophysics and astronomy" [8]. See the "Barycenter of the solar system" at Gravity simulator [9].

12 Hubble expansion

The Hubble expansion of the universe might be applied to a distance of 1 meter.

$$\frac{r}{age} = \frac{1\ m}{4.734E17\ s} = 2.113E\neg 18\ \frac{m}{s}\ per\ meter \tag{12.1}$$

This expansion is too small to measure in the laboratory. The Hubble expansion of the universe might also be applied to the distance of the earth's orbit around the sun.

$$\frac{r}{age} = \frac{149.5E9\ m}{4.734E17\ s} = 3.158E\neg 7\ \frac{m}{s} \tag{12.2}$$

Multiplying by 31556926 $\frac{s}{year}$. In 1 year = 9.966 $\frac{m}{year}$. The earth's orbit expands at ≈10 m per year due to the expansion of the universe within our solar system, if this expansion exists. Unfortunately again, this is an undetectable amount. We will have better luck with the moon using a laser.

$$\frac{r}{age} = \frac{384.4E6\ m}{4.734E17\ s} = 8.12E\neg 10\ \frac{m}{s} \tag{12.3}$$

In 1 year = 25.63 $\frac{mm}{year}$. The Moon's orbit expands at ≈26 mm per year due to the expansion of the universe within our solar system, if this expansion exists.

The Apollo missions to the Moon left behind a laser reflector so that the round trip of laser pulses may be timed and the distance to the moon calculated. The moon is receding from the earth, due it is said to tidal drag, at 38 mm per year.
Who knows? Friction loss due to tidal drag is hard to estimate. It is possible that 26 mm of this 38 mm lunar expansion may actually be due to a Hubble expansion in the solar system.

13 Rosettes

Each of the rosettes on figures (12) to (14) shows the position of the sun and planets against the background stars, looking down on the north pole of the sun. The radial movement of the sun and the radial movement of the planets are to scale. The radius of the orbits of the planets are not to scale. The depth of the lobes reflects the movement of the sun. The petals or lobes are exaggerated when we put them on a page rather than draw them to scale with Pluto's orbit being 8491 times the solar radius. The lobes disappear in the scale of the planetary orbit as the size of the sun's movement becomes minuscule compared with size of the planetary orbits. This is over a period of 247.7 years, the orbital period of Pluto. We look at the position of the sun and planets 2, 7 and 14 times per Mercury year of 88.023 days. Mercury makes 1027.8008 orbits around the sun for every orbit of Pluto. The planets are considered to have circular orbits with respect to the sun but the sun also moves. The planetary orbits and solar orbit are seen as lobed with respect to the background stars because they move together against the practically unmoving background of the stars. The path of the planets appear somewhere in these patterns when the position of each planet is recorded as a dot every 44.01 days. They demonstrate a non-integer harmonic relationship.

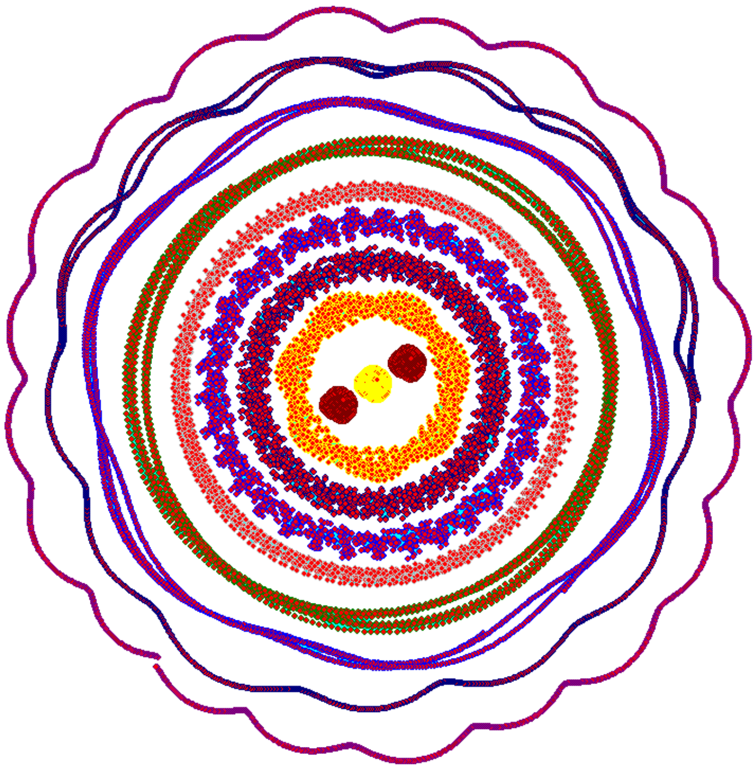

Figure 12: We see the position of the planets and the sun as a dot every 44.01 days for 2055 dots per planet. Each dot is the position of the planet at that moment. The many dots merge into lines. We sample every 44.01 days so we capture our pictures of Mercury twice in its orbit of 88 days when it happens to be in the two little dark circles. This gives the effect of a strobe light freezing periodic motion. Mercury has its orbital motion frozen since we have fixed our strobe-light-periodic-views on its orbital period. The position of Venus is always someplace in the odd seven lobe ring at these times. In the figure, there is a hint of lobes on the inside of earth's orbit and on the outside of Mars' orbit. The orbits interact.

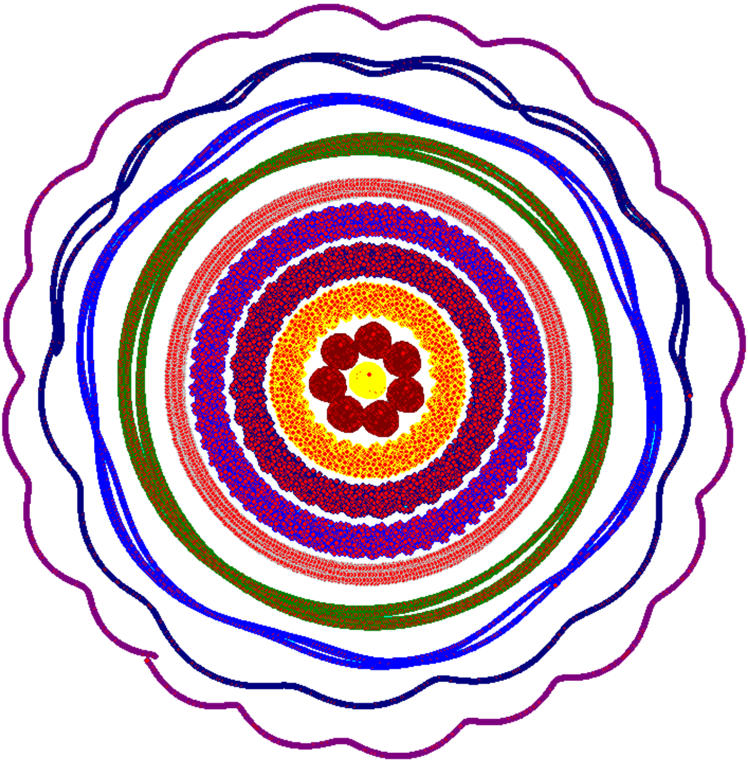

Figure 13: We see the position of the planets and the sun as a dot every 12.57 days for 7194 dots per planet. Mercury has the pattern of 7 little dark circles.

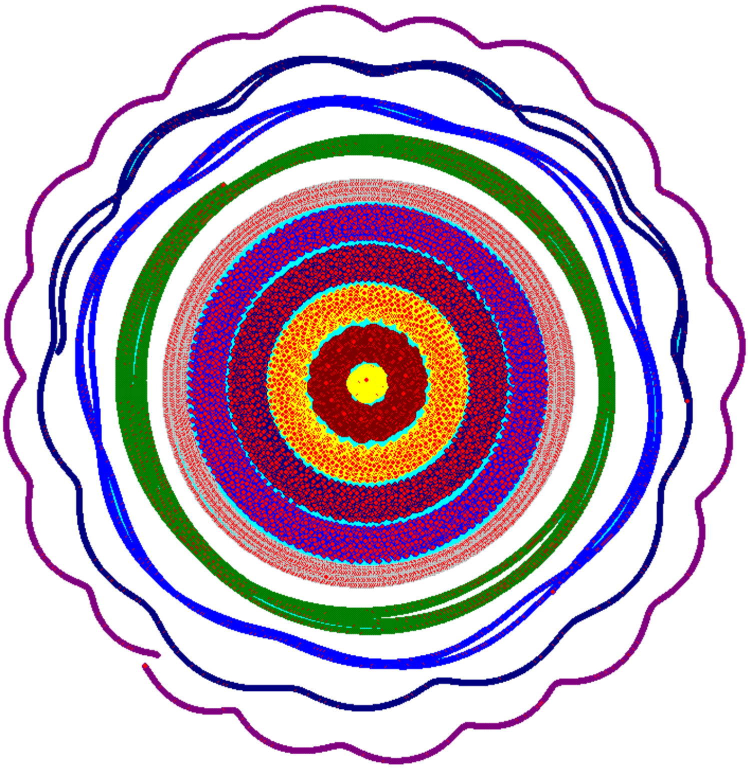

Figure 14: We see the position of the planets and the sun as a dot every 6.28 days for 14389 dots for the sun and each of the nine planets or 143890 dots. The harmonic information, from the inner planets, is lost in a sea of dots.

14 How the wobbles work

1. The mass and orbital period of the planets and other data is recorded from a Planetary Ephemeris. The orbital period of the planets is considered constant and their orbits circular.

2. The angle and distance from the sun for each of the planets was recorded for a certain day.

3. The gravitational force between the sun and each planet was calculated.

4. The x and y components of the forces of all the planets were summed yielding the x and y forces on the sun.

5. The z axis is omitted since the sun and planets orbit nearly in a plane.

6. The sum of these forces when divided by the mass of the sun yield x and y accelerations of the sun.

7. The accelerations were multiplied by the duration of the period of observation in seconds, 44.01 days is 380246 seconds, yielding an x and y solar velocity.

8. This is the velocity added by the solar acceleration.

9. The sun also has a previous x and y velocity from the prior calculation which must be added to this new velocity from the acceleration.

10. The new acceleration changes the direction and velocity of the sun. The sun is considered to move with the sum of these velocities to a new position for each observation.

11. On the graphics each positional dot is a tiny circle filled with a color and outlined by another color.

12. The circles overlap leaving behind the outline colors.

13. The sun is a red circle outlined in yellow which leaves behind yellow as it loops around.

The circular path of the sun only comes from the summation of the x and y components of the planetary force vectors as the planets orbit. The sun orbits as the planets orbit. This is surprising and there is a lot more to this. The central force of gravitation allows rotation in the solar system and the Cosmos. The normal condition for gravitational and electrostatic systems is to orbit, not to fall together. Orbits can be forever. What you see depends on the metaphors you use and the paradigms you follow.

As the sun moves, it drags the planets with it, leaving some of them with lobed orbits. This may look crazy but it is astonishing that we did not see this in elementary school.

The planets move the sun. The planets move with the sun. Their orbital periods and velocity around the sun do not change. Radial movements cause the rosettes. The rosettes are only seen with respect to the fixed reference of the background stars. The center of the sun loops around a variable radius of about two solar diameters or 14E9 meters. The lobes on the planets move the same radial distance. The orbital radius of Pluto is 6E12 meters. 6E12/14E9 is 480 so the lobes on Pluto's orbit would be invisible at this scale. When you can see the whole orbit the lobes are too small to see unless they are greatly magnified. There are 20 lobes in Pluto's orbit because the sun makes 20 orbits for each orbit of Pluto. Neptune has about 13 lobes. Uranus has about 6 lobes. Saturn has about 3 lobes. Jupiter has 1 lobe. Its path looks like a ring but it does move back and forth with the sun. The lobes on the planets are synchronized with the orbit of Jupiter and the sun.

These calculations and graphics were created with a Liberty Basic program [19]. Basic is easy to read since it is text and easy to translate into other computer languages. This is the Solar Wobble Text file of the program [16]. It may be run with Basic.

Astronomers calculate the orbital parameters of extra-solar planets from the visual wobble of a star or the doppler frequency changes as it approaches and recedes from our point of view. When tiny distant Pluto moves, the sun also moves, as they are a binary system. When the sun moves, the Cosmos moves, as they are a binary system. This is how inertia works.

For every action there is an equal but opposite reaction. When you push something, you accelerate it to get it moving, something pushes back. It is the opposite acceleration of the mass of the universe which pushes back. What else could there be to push back? Everything is connected. Everything is a part of a binary system with the universe. Inertia is the acceleration dependent reaction of the observable universe. The observable universe is that part of the totality of everything which has a knowable radius and mass. I like to call it the Cosmos.

15 Orbiting binary systems show how inertia works

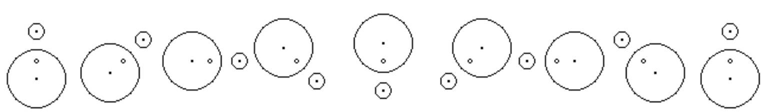

Figure 15: Binary orbits. Both masses move.

The orbiting binary system consists of a rotating dumb-bell of two masses. The mass of the universe

$$mU = \frac{c^3 * age}{G} = 1.9E53\ kg \tag{15.1}$$

is considered as a point at one end of the dumb-bell. A solar mass star

$$mS = 1.9E30\ kg \tag{15.2}$$

is considered as a point far out at the other end of the rotating dumb-bell. The S is for a star near the edge of the Cosmos. mS is the mass of the star. The U is for the universe or Cosmos. Both masses move. There are two each of masses m, tangent and radial velocities, vt and vr, and distance to the barycenter of the system, r.

$$mS * vtS = mU * vtU\ in\ \frac{kg * m}{s} \tag{15.3}$$

Their angular momentums are equal since they are a binary system.

$$mS * rS = mU * rU\ in\ kg * m \tag{15.4}$$

Their mass times distance products are equal and balanced.

$$rS = .9 * c * age = 1.278E26\ m \tag{15.5}$$

The star is at .9 the radius of the Cosmos.
See the radius and mass of the Cosmos in the black hole paper [18].

$$rU = \frac{mS * rS}{mU} = \frac{mS * .9c * age * G}{c^3 * age} = \frac{mS * .9G}{c^2} = 1328\ m \tag{15.6}$$

substituted values for rS and mU. rU is the distance from the center of the Cosmos, to the barycenter of the star-cosmos system. The barycenter of the system is close to the center of the Cosmos because of the huge mass ratio even though the star is near the perimeter of the Cosmos. When a force moves the star one way the mass of the Cosmos moves the other way a very small amount. They are on opposite sides of the barycenter of a binary system which can be thought of as a lever and fulcrum.

$$\frac{vtS}{rS} = \frac{.9 * c}{.9 * c * age} = \frac{1}{age}\ in\ \frac{1}{s} \tag{15.7}$$

$$\frac{vtS}{rS} = \frac{vtU}{rU} = \frac{1}{age} = Hubble's\ constant\ in\ \frac{1}{s} \tag{15.8}$$

This is equation (15.3) divided by (15.4). The angular velocity in radians per second is the orbital velocity of the object divided by the distance to the barycenter. They are equal since they are a binary system.

$$vtS = \frac{rS}{age} = \frac{.9 * c * age}{age} = .9 * c = 269813212\ \frac{m}{s} \tag{15.9}$$

$$vtU = \frac{rU}{age} = \frac{1328\ m}{4.73E17\ s} = 2.8E\neg 15\ \frac{m}{s} \tag{15.10}$$

15.1 Centrifugal forces

centrifugal force of the star = centrifugal force of the Cosmos

$$\frac{mS * vtS^2}{rS} = \frac{mU * vtU^2}{rU}\ in\ \frac{kg * m}{s^2} \tag{15.11}$$

This is equation (15.3) times (15.8) or:

$$\frac{mS * vtS}{age} = \frac{mU * vtU}{age}\ in\ \frac{kg * m}{s^2} \tag{15.12}$$

This is equation (15.3) times $\frac{1}{age}$. Their gravitational and centrifugal forces are equal. Centrifugal force exerts its force in a radial direction perpendicular to the tangent velocity vt of its mass. This is mass times a radial acceleration. There is acceleration because the mass is changing directions in deviating from a straight line as it follows a circular path.

15.2 Using radial velocities in an expanding system

$$mS * vrS = mU * vrU\ in\ \frac{kg * m}{s} \tag{15.13}$$

The radial momentums are equal in an expanding system.

$$\frac{vrS}{rS} = \frac{vrU}{rU} = \frac{1}{age} = Hubble's\ constant\ in\ \frac{1}{s} \tag{15.14}$$

$$vrS = \frac{rS}{age} = \frac{.9 * c * age}{age} = .9 * c = 269813212\ \frac{m}{s} \tag{15.15}$$

This is the radial velocity of the star with respect to the barycenter of the star-cosmos system. The star is at .9 the radius of the Cosmos. It has a radial and tangent velocity of .9 the speed of light. Since it has a radial and tangent velocity, it is spiraling out, like everything else in the Cosmos.

$$vrU = \frac{rU}{age} = \frac{1328\ m}{4.73E17\ s} = 2.8E\neg 15\ \frac{m}{s} \tag{15.16}$$

The center of mass of the Cosmos is also spiraling out but very much slower.

15.3 Coriolis forces

$$\frac{2 * mS * vrS}{age} = \frac{2 * mU * vrU}{age}\ in\ \frac{kg * m}{s^2} \tag{15.17}$$

This is equation (15.13) multiplied by $\frac{2}{age}$. The coriolis force is caused by a radial velocity and exerts its force in a tangent direction perpendicular to the radial velocity. These are two equal but opposite Coriolis forces. This is mass times a tangent acceleration.

15.4 Tangent deceleration force

$$\frac{mS * vrS^2}{rS} = \frac{mU * vrU^2}{rU}\ in\ \frac{kg * m}{s^2} \tag{15.18}$$

This is equation (15.13) multiplied by (15.14).
Centrifugal force is a radial outward force $\frac{mass*vt^2}{r}$.
This is a perpendicular tangent force $\frac{mass*vr^2}{r}$.
rS = vrS * age and rU = vrU * age so we can write:

$$\frac{mS * vrS}{age} = \frac{mU * vrU}{age} \tag{15.19}$$

This is equation (15.13) multiplied by $\frac{1}{age}$.
The tangent deceleration forces are equal in an expanding Cosmos. This is half the coriolis force and in the opposite direction. It cancels half the coriolis force. There is a decreasing acceleration because it decreases with age and because the mass is changing direction in going from a smaller circular path to a larger circular path, to a more straight line path, as the radius increases as the Cosmos expands. These solar and cosmic forces are equal and decrease as the Cosmos expands and slows down in its rotation.

16 Force summary

Centrifugal force exerts its force in a radial direction, in a direction perpendicular to the tangent velocity vt of its mass.
Coriolis force and tangent deceleration force exert their force in a direction tangent to a circle, in a direction perpendicular to the radial velocity vr of its masses. In the expanding Cosmos, vt = vr, everything is expanding and rotating and everything is spiraling out.

The two centrifugal forces and one gravitational force are equal. The two Coriolis forces are equal. The two tangent deceleration forces are equal.

17 Cosmic Expansion

Now that we have calculated the inertial forces, we can look at the way the Cosmos expands. We have the

$$centrifugal\ acceleration = \frac{vtU}{age} \tag{17.1}$$

directed radially out. vtU = vrU. We have the

$$coriolis\ acceleration = 2 * \frac{vrU}{age} \tag{17.2}$$

in the direction of rotation, and the

$$rotational\ deceleration = \frac{\neg vrU}{age} \tag{17.3}$$

in the direction opposite of rotation. The resultant of these accelerations, is 45 degrees between the direction of rotation and the outward directed radius. It has a value of,

$$\sqrt{2} * \frac{vrU}{age}\ in\ \frac{m}{s^2} \tag{17.4}$$

A particle or Cosmos moving in this way traces out a logarithmic spiral.

18 Inertia

A force on a star S equals the opposite force on the universe U so,

$$Force\ S = force\ U \tag{18.1}$$

Newton's third law. Forces come in pairs. For every action there is an equal but opposite reaction. The reaction is due to the acceleration of the Cosmos U.
mS = 1.9E30 kg is the solar mass and aS is the acceleration.
$mU = \frac{c^3 * age}{G}$= 1.912E53 kg is the mass of the Cosmos and aU the acceleration of the Cosmos.

$$aU = \frac{aS * mS}{mU} = aS * \frac{1.9E30\ kg}{1.9E53\ kg} = aS * 1E\neg 23 \tag{18.2}$$

The acceleration of the Cosmos in reaction to the star's acceleration is microscopic. When a force is applied to the star, the star is accelerated. The Cosmos has its own tiny acceleration for this force since accelerations are proportional to mass. These tiny accelerations over time produce a velocity. The Cosmos mirrors these movements in the same way the sun mirrors the movement of the planets. When a planet or a star or anything is accelerated, the Cosmos is accelerated. The acceleration of the Cosmos explains inertia.

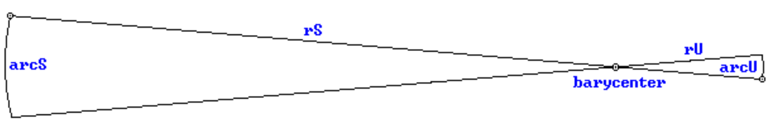

Figure 16: Orbit segments

Arc segments arcU and arcS are the angular arcs that the Cosmos and the star follow during their orbits. The angular movements are equal but rU and rS, the distances to the barycenter, are vastly different.

$$arcU * rS = arcS * rU,\ arcS = 1\ degree \tag{18.3}$$

$$arcU = \frac{arcS * rU}{rS} = \frac{1\ degree * 1328\ m}{1.278E26\ m} = 1.04E\neg 23\ degree$$

If the star moves 1 degree, then the Cosmos moves in the opposite direction, across the barycenter, 1.04E¬23 degrees.

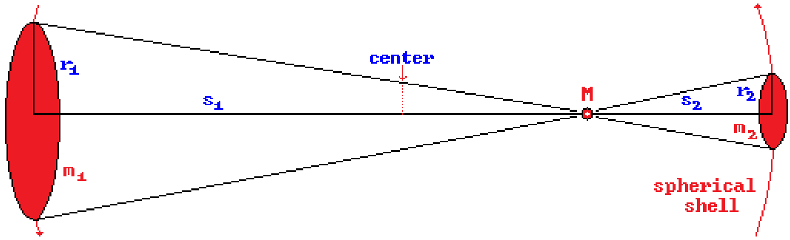

Figure 17: Gravity inside a spherical shell. An object of mass M is attracted equally from both sides of a static spherical shell. This equality of gravitational forces is true for any size and density of static shell.

19 Newton

Newton gave us the idea that the mass of a body may be considered to be concentrated at a point at the center of the body and that gravitational forces can be considered to act between these points. Concentric shells of mass may be considered to be concentrated at a point, in the center of the shells. Concentric shells of mass cause no resultant force on a body within static shells [24].

$$tan(\theta) = \frac{r_1}{s_1} = \frac{r_2}{s_2} \; implies \; \frac{r_1}{r_2} = \frac{s_1}{s_2} \; or \; \frac{\pi r_1^2}{\pi r_2^2} = \frac{s_1^2}{s_2^2} \tag{19.1}$$

$$\frac{force_1}{force_2} = \frac{\frac{GMm_1}{s_1^2}}{\frac{GMm_2}{s_2^2}} = \frac{m_1}{m_2}\frac{s_2^2}{s_1^2} = \frac{\sigma A_1}{\sigma A_2}\frac{s_2^2}{s_1^2} = \frac{\pi r_1^2}{\pi r_2^2}\frac{s_2^2}{s_1^2} = \frac{s_1^2}{s_2^2}\frac{s_2^2}{s_1^2} = 1 \tag{19.2}$$

m is the mass of the spherical caps of σ density and area A. This equality of gravitational forces is true for any size and density of static shell. For an expanding and rotating shell, M will have a radial and tangent velocity, centrifugal, coriolis and tangent deceleration forces. Mass m_1 and m_2 are receding at the speed of light at the perimeter of the Cosmos. Both have different velocities of recession from M.

20 Conclusions

As the objects in the Cosmos move, like the planets in the solar system, the center of the expanding concentric shells of mass of the

Cosmos traces the sum of their movements around the barycenter of the Cosmos.

The movement of the Cosmos around the barycenter of the system uses the same mechanics as the movement of the sun on its wobbly path around the barycenter of the solar system.

References

[1] Orbit Wobble animation @ http://www.blackholeformulas.com/files/orb.gif

[2] Conical pendulum @ http://www.blackholeformulas.com/files/cp5.gif

[3] Van Flandern @ http://www.metaresearch.org/cosmology/speed_of_gravity.asp

[4] Planetary Data @ http://www.blackholeformulas.com/files/planetary.html

[5] Electric Gravity @ http://www.blackholeformulas.com/files/electricgravity.html

[6] Bohr Atom @ http://www.blackholeformulas.com/files/BohrAtom.html

[7] Solar System Barycenter @ http://en.wikipedia.org/wiki/Barycentric_coordinates_(astronomy)

[8] Barycenter @ http://www.en.wikipedia.org/wiki/Center_of_mass#Barycenter_in_astronomy

[9] Orbit Simulator @ http://www.orbitsimulator.com/gravity/articles/ssbarycenter.html

[10] Orbit x,y @ http://www.blackholeformulas.com/files/orbxy.gif

[11] Orb2 gif @ http://www.blackholeformulas.com/files/orb2.gif

[12] Orb7 gif @ http://www.blackholeformulas.com/files/orb7.gif

[13] Orb14 gif @ http://www.blackholeformulas.com/files/orb14.gif

[14] Solar Disk gif @ http://www.blackholeformulas.com/files/orbsun.gif

[15] Solar Path gif @ http://www.blackholeformulas.com/files/orb2020.gif

[16] Solar Wobble Text @ http://blackholeformulas.com/files/solarwobble.txt

[17] Bitmap Font Writer @
http://www.stefan-pettersson.nu/bmpfont/
The fuzzy edges of most fonts look bad in bitmapped graphics. Graphics need bit-mapped fonts, .fon. You can make your own with this bit mapped font editor. Multi color fonts and a different approach can be seen with this great free program which was used on many of my figures.

[18] Black Hole Paper @ http://www.blackholeformulas.com/files/orbitinglight.pdf

[19] Liberty Basic @ http://www.libertybasic.com/
Basic was used for most of the calculations and graphics. The images were cleaned up with Paint and Irfanview

[20] IrfanView @ http://www.irfanview.com/
A great free image viewing and processing program.

[21] Unfreez @ http://www.whitsoftdev.com/unfreez/
The movies were made with unFREEz, a great free gif animation tool.

[22] Solar Wobble Text @
blackholeformulas.com/files/solarwobble.txt

[23] Paul Marmet @
intalek.com/Index/Projects/Research/FundamentalNatureOfRelativisticMassAndMagneticField.htm

[24] PhysicsLab @
http://dev.physicslab.org/Document.aspx?doctype=3&filename=UniversalGravitation_UniversalGravitationForces.xml

Go to Index @ http://blackholeformulas.com