Journal of Aeronautics & Aerospace Engineering

Junior, J Aeronaut Aerospace Eng 2015, 4:2
DOI: 10.4172/2168-9792.1000145

Research Article Open Access

Paradoxical Variation of the Solar Day Related to Kepler/Newton System

Luiz Sampaio Athayde Junior*

Professor at School of Accounting Sciences, Federal University of Bahia, Brazil

Abstract

According to the first law of Kepler, the planets orbit the sun in elliptical path. This ellipse causes a slowdown in the world when it goes from the nearest point of the sun to the farthest point and also causes acceleration when the opposite occurs. This variation of the velocity of the planet combined with the inclination of its imaginary axis creates the analemma chart, which can be found with the overlap of the positions of the sun in a particular location always in the same timeset on a watch. The analema, in turn, describes variations in the durations of the solar day. In some dates, these variations in solar days occur in accordance with the change in velocity of the planet, but at other times, they get along perfectly Conversely, showing in some parts of the solar days year that will gradually reducing their periods as the planet decelerates and also increases periods as the planet accelerates.

Keywords: Kepler's laws; Law of universal gravitation Newton; Analemma; Equation of time; Solar day

Introduction

Due the laws of planetary motion, specifically described by the first law of Kepler and the law of universal gravitation of Newton, the planets have speed variations in its orbit by traffic and also in its rotation.

Because of the speed variations the meridian passage of the sun on your east of apparent westward movement across the planet also occurs with varying speed, and its faster passage when the planet is slower when compared to the time of a clock, and slower when the planet is faster. If we took pictures of where the sun shines in the zenith every day in a same time on the clocks, considering only the variation described speed, the analemma would be a horizontal line, describing only the delays and lates of light in its apparent movement. However, the planet also has an inclination in its imaginary axis, which gives rise to the seasons, specifically in the temperate zone, which makes the analemma also present a variation between north and south and in their form as we know, that resembles the number eight or infinity symbol.

The variations in the analemma chart indicate variations in periods of solar days that in some parts of the year occur concurrently with the change in velocity of the planet, that is, when the planet accelerates, periods of solar days successively decrease and the opposite also. However, the chart also shows that in other parts of the year variations occur completely contrary to variations in the speed of the planet, in which slows down the planet and the sun days have successively decreasing periods and otherwise, too.

In studies of physics, it uses the concept of speed for moving bodies, as stated in relation to the planets, while for the solar day, which is not a mobile; the term is used in reference to the period duration.

Solar days measurements were taken on a few dates for demonstration of paradoxical changes in periods of solar days.

Theoretical

Solar day

According to Oliveira Filho and Saraiva, solar day is "the time interval between two successive passages of the sun across the meridian of the place". Can be measured with a gnomon that can demonstrate the meridian passage of the sun on a date and the next date.

Not to be confused with the 360° rotation around the imaginary axis itself and also according to the authors:

It's 3 m 56 s and longer than the sidereal day because the sun is moving in the opposite direction of diurnal motion, that is, from west to east. This difference is due to the Earth translation movement around the Sun, of about 1 degree (4 minutes) per day (360/y = 360°/(365.25 days) = 0.9856°/day) (Figure 1).

Thus the solar day is longer than a full rotation of 360° on the planet, because when the sun in its passage east to west, focuses exactly on the meridian passage of a certain locality, only focus again on the same meridian passage or that same Location ~360,9856º and not the exact 360 what would be a complete rotation of the planet around its imaginary axis.

The difference occurs because the time of one complete rotation of the planet space is also moving along its orbit.

The laws of Kepler

Johannes Kepler, German astronomer who lived between 1571 and 1630, although it has not given due importance in the time he published his works, formatted the three laws that describe the motions of the planets, published in different works and not in the same work, that are named today as the three laws of Kepler.

Various trigonometric operations were employed to design the first two. For them, we used data from another important astronomer who preceded him called Tycho Brahe, referring to its observations on the planet Mars.

Working with Brahe, Kepler could conceive the first of its laws, which states that the planets orbit around the sun not in circular orbits,

***Corresponding author:** Luiz Sampaio Athayde Junior , Professor at School of Accounting Sciences, Federal University of Bahia, Brazil, Tel: 55 71 99211 93; E-mail: sampaioathayde@yahoo.com.br

Received September 26, 2015; **Accepted** October 15, 2015; **Published** October 24, 2015

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

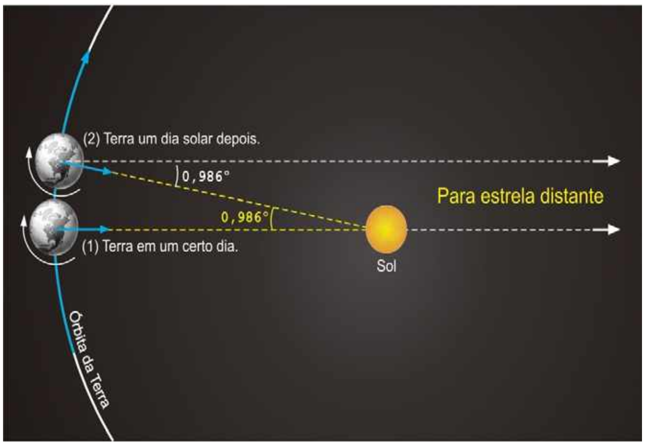

Figure 1: Solar Day.

but in elliptical orbits and the Sun is at one of the focus.

The second teaches us that an imaginary radius of the orbit, joining the sun to the planet takes equal areas in equal times. When the planet is closer to the sun logically has lower imaginary rays than when the planet is farthest.

Kepler also found that when this is the earliest time, position called perihelion or perigee, the planet moves faster in its rotation and its translation and the opposite occurs when the planet is farthest from the sun, called aphelion position or height when travels slower through its orbit and also features slower speeds.

The University of Nebraska in United States of America - USA, provides on its website several simulators of planetary movements, through its Nebraska Astronomy Applet Project - NAAP. We will use here some pictures of the simulator entitled Planetary Orbit Simulator to help us understand Kepler's Laws.

Let´s check the demonstration of the first law in Figure 2.

To improve the understanding of the subject, we can determine, through controls of the simulator, the empty focus, which is in opposition to the sun, the center of the ellipse, besides the semimajor and semimenor, or larger radius and smaller radius of the ellipse, as is done in the figure. When opens the simulator is already selected Mercury, having more eccentric ellipse, which also helps to understand. The simulator also allows increase esssa eccentricity for better visualization of the listed laws, by controlling "eccentricity". Now a graphic demonstration of the second law for the same simulator is shown in Figure 3.

The simulator lets you paint areas covered by the planet at the same time at the moment is slower and faster (when it's out of the sun or closer, respectively). Obviously when slower travel a shorter distance in its orbit, as it were, than when it is faster. Kepler discovered that the painted areas (as shown in the simulator) of two imaginary triangles formed by imaginary rays of the planetary orbits, are equal. This is a very important finding in an attempt to derive the planetary motions by physical causes. If we consider the time in which he lived, we can not fail to recognize how much is an amazing discovery.

Finally, in the year 1619, was published work called Harmonices Mundi by Kepler, in which it is prescribed that the square of the orbital period of the planets is directly proportional to the cube of the average distance of the planet to the Sun, which is known today as your third law. The simulator present, is hereinafter in this work simply first simulator.

Consider the graphic demonstration of tarceira law of Kepler in the simulator (Figure 4).

Law of Newton gravitation

After finding that the land attracted all objects, starting with the picturesque episode of the falling apple, Isaac Newton further narrowed the ties between physics and astronomy through his Law of Universal Gravitation. He also concluded that the same way force that attracted the objects to the Earth center kept the moon in orbit around them and the planets around the sun. In a single theoretical framework, Newton was able to explain all gravitational phenomena (Figure 5).

The title of his work is PhilosophiaeNaturalis Principia Mathematica. It derived Kepler's Laws of first principles. Thus, many of the foundations of modern physics were created by theoretical

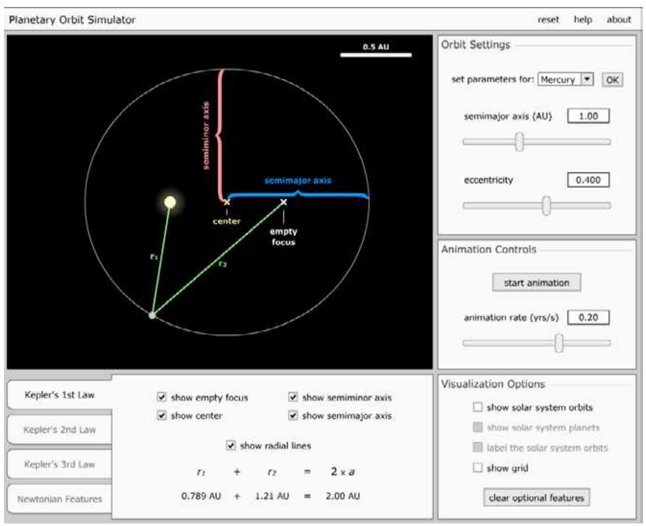

Figure 2: First Kepler's Law.

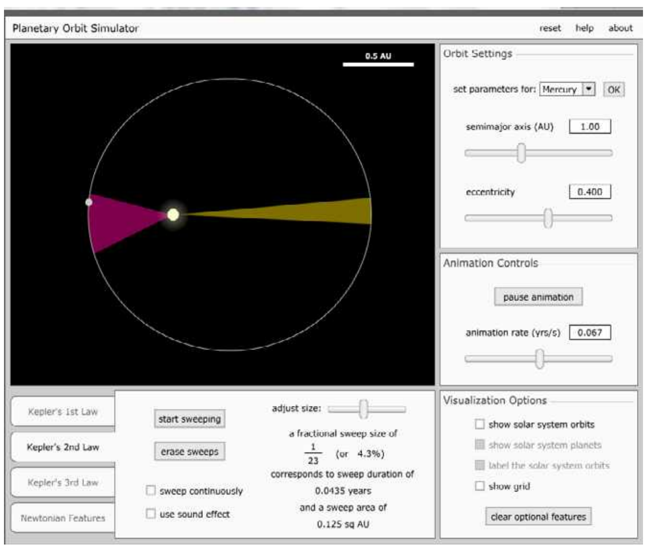

Figure 3: Second Kepler's Law.

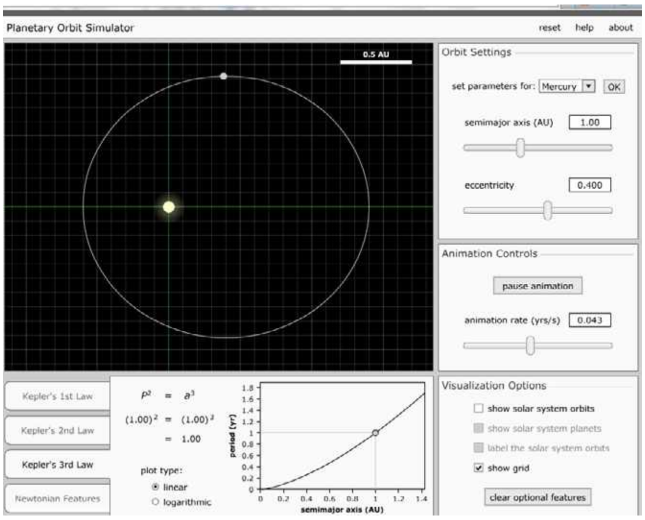

Figure 4: Kepler's Third Law.

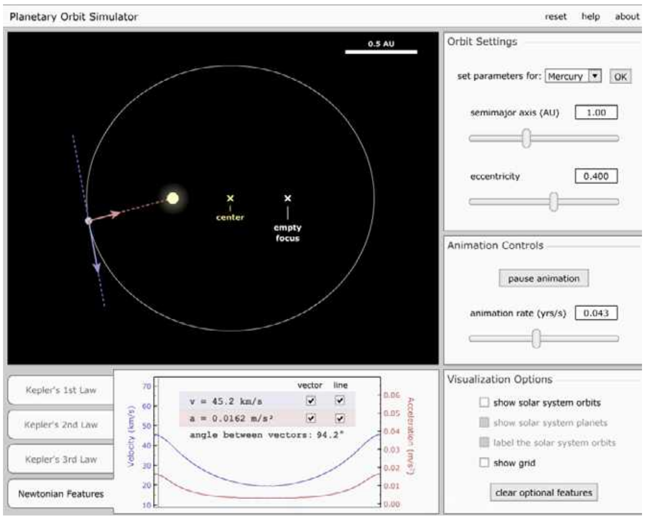

Figure 5: Newtonian Contribution to Kepler's Laws (position close to perihelion).

contribution of Newton. Let´s check the next two images of the first simulator (Figure 6).

When the planet is close to the called perihelion position, which is the time when it is closer to the sun, the incidence of gravity that for Kepler, was unknown, the simulator shows by the application and overlapping vectors of design Larger than when the planet is near aphelia call position. In this, the speed and severity of the conditions are reversed from the first.

In the existing chart at the bottom of the figures is shown another influence of gravity newtoneana, justifying the higher or lower acceleration and velocity of the planet.

If the planet moves faster, our watches mark noon, but the sun's apparent motion is delayed manner, which makes it not occur meridian passage of the star. Around this time of the year, approximately 05/01, the sun rises and sets later for other dates. Similarly, when the speed of the planet is slower, the sun sets and rises early, causing its apparent motion becomes earlier, causing the meridian passage of the star before noon on the clocks. These speed variations of the planet throughout the year and the slope of the imaginary axis of the planet relative to the orbital plane of about 23.5° originate the analemma phenomenon.

The Analemma

We know that the sun's apparent motion over one day, takes place from east to west, given the planet's rotation is from west to east. Over a year, the apparent motion of the star is between the north and the south, given the slope of the imaginary axis of the planet and so the sun peaking north on the day of the summer solstice for the northern hemisphere and reaches the most southern of the date of the southern summer solstice.

However, if we observe the sun's path between the north and the south, always in the same time on the clock in the one year period of time, we will not find a straight chart, but a similar way to the infinity symbol or a number "eight", which is the phenomenon known as Analemma.

One of the most common forms of his observation is taking pictures of the sun's position in the sky with ten intervals in ten days or every seven for one year always in the same time displayed on a watch. Making an overlay of all the photos you can see the chart clearly demonstrated, or by making an animation between them we can see the outline of the "eight", so to speak, throughout the year.

The reasons for the phenomenon to occur can be explained by the first law of Kepler, and the fact that the imaginary axis of the planet has an inclination of about 23.5°. If the planet had perfect circular orbit, there would be no change in velocity, so the only analemma would be a vertical line on north-south direction. If, added to the hypothesis of perfect circular orbit, there were no imaginary axis inclination, then the analemma would be only a single point, overlapping the images of the sun over a year. In one last assumption, there were no axial inclination but the orbit was elliptical, as indeed is the analemma chart would only be a horizontal line, with variations only between east-west. With the combination of the elliptical orbit (first law of Kepler), which causes variation in the speed of the planet and delays and sun advances regarding our watches, and the slope of the imaginary axis, causing the

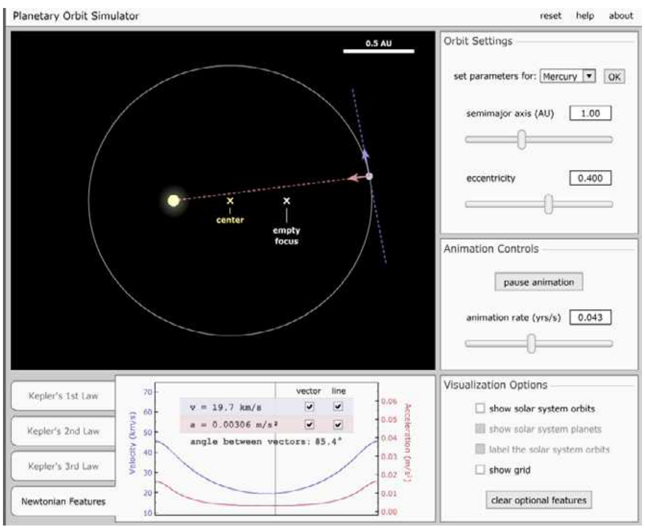

Figure 6: Newtonian Contribution to Kepler's Laws (position close to aphelion).

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

north-south variation of the analemma During successive positions for one year, the phenomenon is properly configured.

The analemacan also be shown at any location that can be achieved sunlight throughout the year, just to cause both a shadow with a gnomon or a stick placed on the ground or on a wall where the shadow is projected. If the shadow of the points are united tip this rod throughout the year and always in the same time on a clock, the graph into infinity symbol shape will be found. This is a very didactic and requires great simplicity of materials used for demonstration of the phenomenon, especially for students.

In the next parts of this work will bring some additional explanations about the approximate date and chart positions described through images and simulators for teaching purposes, with the primary objective of demonstrating the dates correlated with the position that the sun is on the analemma graph to throughout the year. Analemma image seen in the sky shown in Figure 7.

Simulator of Sun Movings

In order to know in detail the sun's apparent motion will use other simulator NAAP/UNL, entitled Sun Motions Demonstrator, hereinafter called here simply second simulator (these movements are apparent because it is actually not the sun that moves on planet, but the earth revolves around the star).

We set the latitude in the small world map to the right to Salvador/Bahia. To do so, putting the value of 12.9 degrees south latitude, since the simulator works with only one decimal and decimal fractions.

We can see a little shadow on the side and in front of the spectator represented by a stickman because of analemma position, on the date that is shown. We should mark the "show analemma" controls on the left and below to appreciate the graphic phenomenon throughout the year and "show month labels" to view the position of the sun in the location chosen for the passage of the calendar.

Viewing the occurrence of successive days, however, we must keep track "step by day" clicked for the watch remains frozen at noon, for better observation of the occurrence of the analemma phenomenon over an entire year is possible and including repeat for as many times

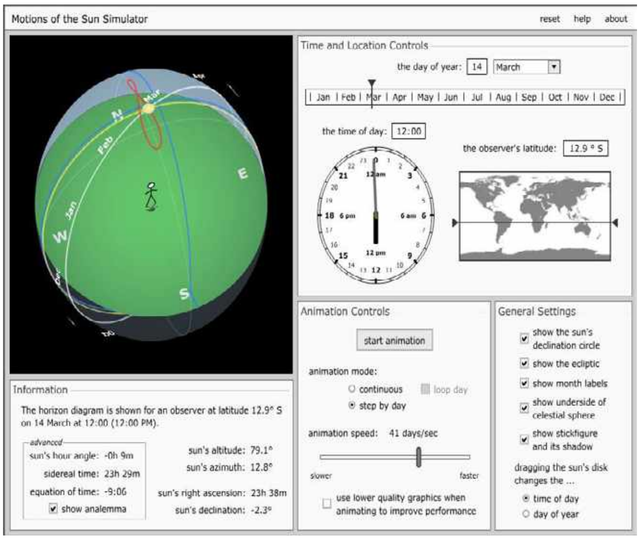

Figure 8: Sun Movements of Simulator.

as desired, simply click the "start animation" always to start or stop the cycle. The simulator also allows, among many other possibilities, with a click made in the calendar arrow, the occurrence of the dates on the contrary, if the desire of those who operates by dragging the pointer with the mouse click (Figure 8).

A Translation with two Simulators

The date of the aphelion, orbital position where the planet is farthest from the sun, by the USNO table, always occurs in the first days of July. In 2012 and in 2013 it was 07/05. It will vary but not much, will always be between July 3rd to 6th until 2020.

However the date of perihelion position in the orbit where the planet is closest to the sun, which in 2012 it was wasjanuary5th and in 2013 it was in was January 2nd, it also will not vary much, will always atay between January 2nd to 5th January 2020.

We can only be sure of these two dates in the first simulator, since it does not have a calendar to show simultaneously month and positions as in the second one. Thus, the positions on other dates will be suggested in the first and not so accurate but without prejudice to any understanding of the content or for attaining the objectives of this work [1].

Obviously our translation described and demonstrated by the images of the simulators will only deadlines of analemma locations and dates of the aphelion and perihelion and not 365 days to prevent the aggrandizement of this text. We also believe that the intervals and the consecussion of the images are sufficient for understanding the occurrence of the translation and its visualization in both simulators.

Starting our translation on the date of 21/12, which is the date of the summer solstice for the southern hemisphere. In the first simulator, is a date before the position of the perihelion (closest planet to the sun, which is ~ 01/05) and the second the sun is at the southernmost point of the analemma (Figures 9 and 10) [2].

After 21/12 the next date for the demonstration is ~ 01/05, which is the date of perihelion.

We can see in the simulators that the planet moves along the

Figure 7: The Sun Analemma Seen From Earth.

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

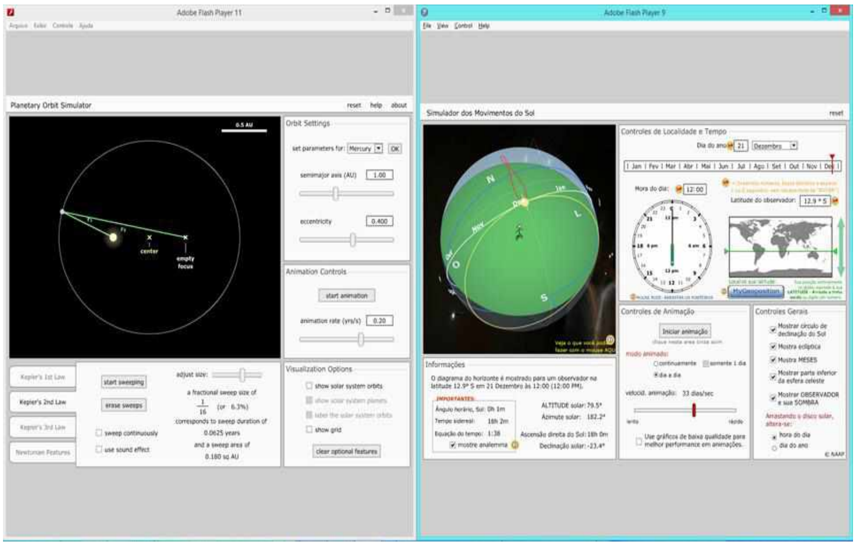

Figure 9: Simulators in the Position of ~ 21/12.

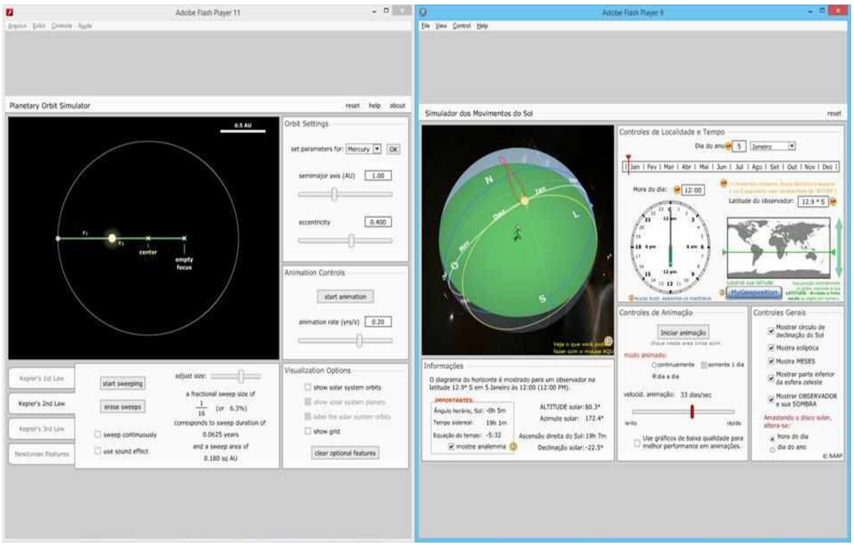

Figure 10: Simulators in the Position of ~ 01/05.

analemma, going towards its lower half in point further east, as the second simulator and is now perfectly pointed to the left in the first, which is one of the dates that we can identify this simulator as cited and reaches the approximate date of ~01/05, which is the date of perihelion.

So if we're on the earliest date the sun, ~01/05, the planet is at its fastest time but the solar day will still showing periods smaller and smaller, ie, will still be with his "speed" increasing to ~02/12 , which is the date on which the solar day has its shorter period, ie, is "faster", as can be seen (Figure 11) [3].

In the second simulator, this date (02/12) is the most eastern part of the larger half of the analemma (a time limit, so) and the first simulator that shows the orbit, at some point after the position where the planet was closest to the sun when it was perfectly on the left of our screen.

Leaving ~02/12, there are successive periods longer solar day, or decreasing variation of the "speed" of the same and thus the solar day "slow down" to the approximate date of 04/12. On this date, the planet passes through the midpoint in the second simulator, just between the two arches of the "eight" which is the approximate shape shown analemma [3]. The orbit of the planet, or the first simulator, however, although it is a date of "speed" balanced the solar day, you can not be sure of the position, for lack of an attached schedule, if that date is reached point where r1 equals r2 (at which the speed of the planet is average). There are dates on which the period of the solar day is average, namely ~06/21 or northern solstice, ~21/12 or southern solstice and on the dates through the central apex of the analemma ~04/12 and ~08/ 31 (Figure 12).

After ~04/12 to reduce the daylight savings time or a "deceleration" continues only for a "speed" smaller than average because analema followed by the planet is at its maximum point of the lower half west or

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

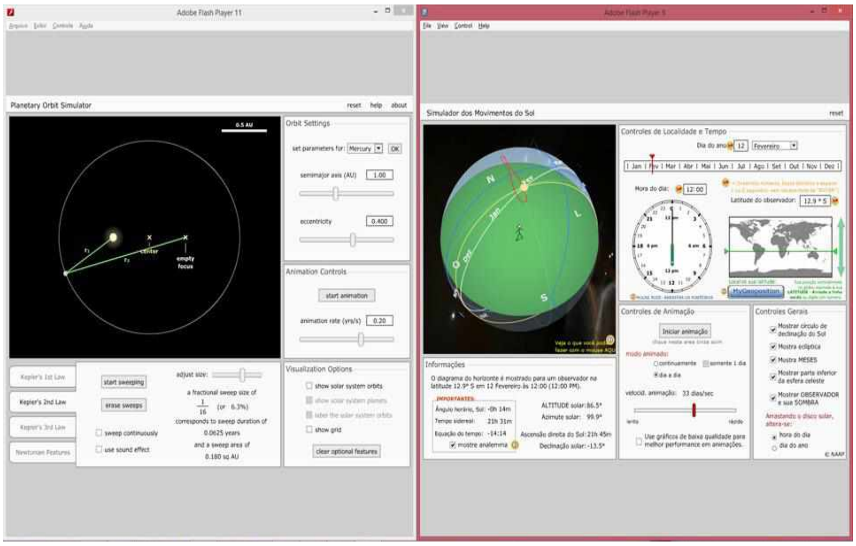

Figure 11: Simulators in the Position of ~ 02/12.

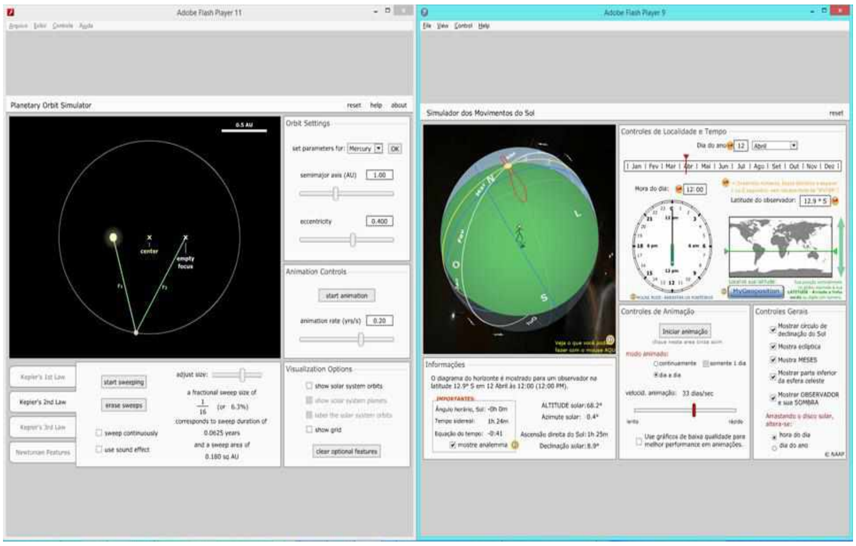

Figure 12: Simulators in the Position of ~ 04/12.

north of it half the approximate date of 05/11 (Figure 13).

The first simulator is in any position before the point entirely right (only come on that date at aphelion, ~07/ 05 and before that still occur the 06/21 deadline) (Figure 14).

Going from ~05/11 solar day reduces its periods, or “accelerates”, even though the planet is heading toward aphelion, which is ~07/05. After ~05/11, so the planet reaches the approximate date of the summer solstice in the northern hemisphere, the approximate date of 06/21, where the solar day duration periods are average again, as aforesaid (Figure 15). Remember that from 01/05 to 07/05 the planet is slowing down. On this date the planet is in position in the second simulator date ~06/21 (summer solstice in the northern hemisphere and most northern point of the analemma) and the first, the planet points almost perfectly right.

Continuing with the unlikely reducing periods of solar days, which contradicts the slowdown in the world demonstrated by Kepler and Newtonian gravitation explained by (perihelion to aphelion only), periods of solar days, decrease (or “speed”) even after passes through the planet aphelia, ~07/05 to 07/25 approximate date when the sun reach the maximum point on the second simulator east, still in the northern half of analema.

In the first simulation, the date of ~07/05 which is the aphelion, the planet is pointing perfectly to the right of our screen (one of the two dates we can be sure that simulator) and the second already exceeds the most northerly point, at the east toward the lower or upper half of the analemma [4].

On the date of ~ 07/25 the first simulator is in a position after the aphelion (~07/05), she points at up and right. The second shows the

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

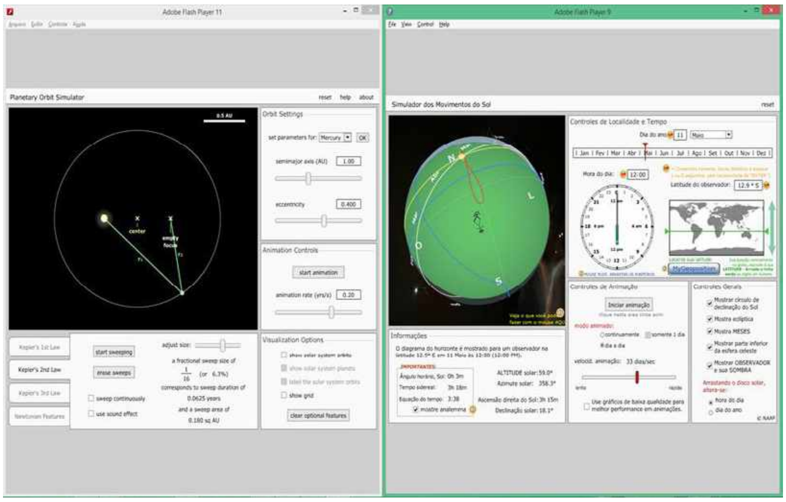

Figure 13: Simulators in the Position of ~ 05/11.

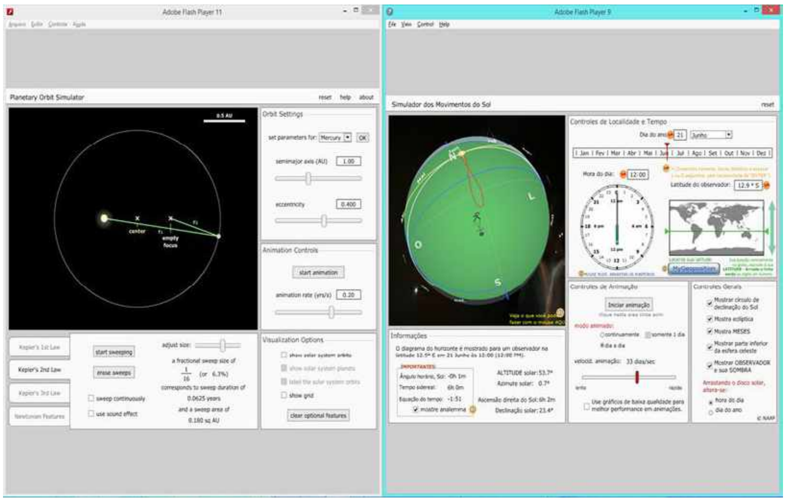

Figure 14: Simulators in the Position of ~ 06/21.

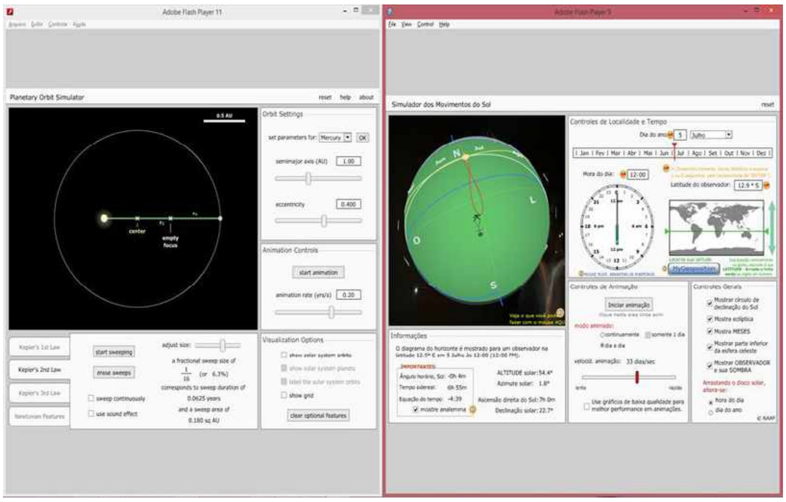

Figure 15: Simulators in the Position of ~ 07/05.

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

sun through the top half of the analemma in its time further at east (Figure 16).

After only reduced periods of solar day to ~07/25, these increase again increasingly showing a trend of "deceleration" up to the date of the slowest day of the solar year, which is ~11/03, noting that just before he will by the average speed again in ~08/31, when going through the central apex of the analemma (now headed 7back), the second simulator (Figure 17).

This "slowdown" or an increase in the solar day periods is also unlikely because the planet is heading toward perihelion, given the laws of universal gravitation.

In the first simulation, the date of ~08/31 will still be a little more to the left (now on top in our video), but will still be before r1 = r2, because this equality only occurs on the date that the imaginary radius ellipse, (between the planet and the sun) is medium, the exact half between aphelion and perihelion and there is no perfectly gauge the date of occurrence that through the first simulator [5].

After ~08/31 solar days follow as well, contrary to Newtonian gravitation and the first Kepler's Law again, "slowing down" until the date of ~11/03, as the planet is accelerating, with the second simulator at the west position the higher half, which is the date of the slower solar day in the year and the first simulator further pointing to the left (Figure 18).

After the date of ~11/03, the solar day finally begins a series of shorter periods, ie its "acceleration" (now congruently with the planet), and reaches the southern solstice ~21/12, which can be clearly seen in the second simulator, where the speed of the solar day is average and the location is perfectly in the southernmost point of the analemma. At first, this time is when the planet is in the position pointing up and to the left on our screen, before pointing perfectly to the left (because there would be the date of perihelion, ~01/ 05). This concludes the translation with an image identical to that of departure (Figure 19).

Extrapolating a little translation, the reader of the case which is fixed over the first simulator, once used as a delimiter for the positions of the second solstice, it should be recalled that thereafter the solar day following "accelerating", ie showing periods smaller and smaller until you pass the perihelion ~01/05 [6].

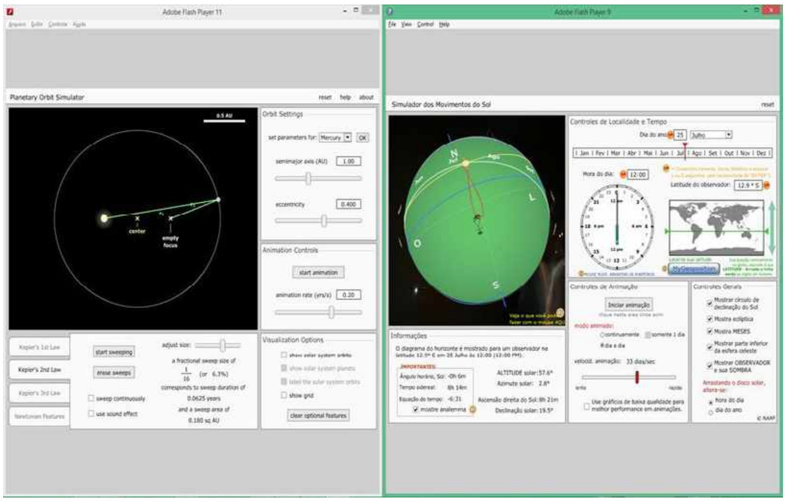

Figure 16: Simulators in the Position of ~ 07/25.

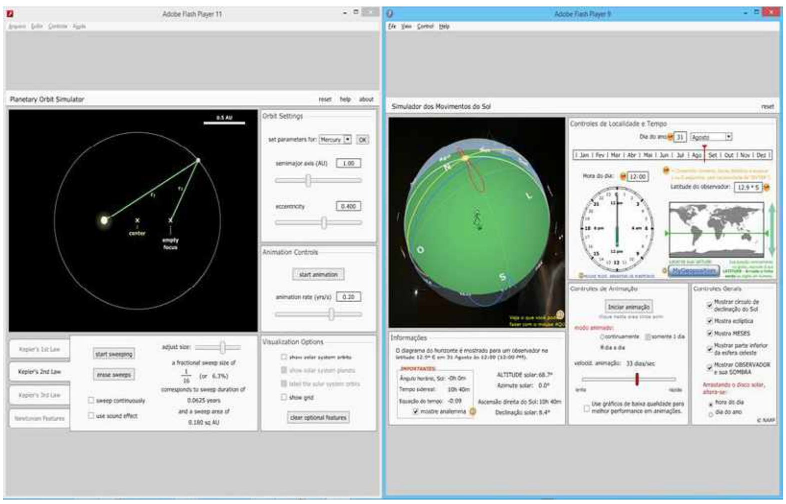

Figure 17: Simulators in the Position of ~ 08/31.

Citation: Junior LSA (2015) Paradoxical Variation of the Solar Day Related to Kepler/Newton System. J Aeronaut Aerospace Eng 4: 145. doi:10.4172/2168-9792.1000145

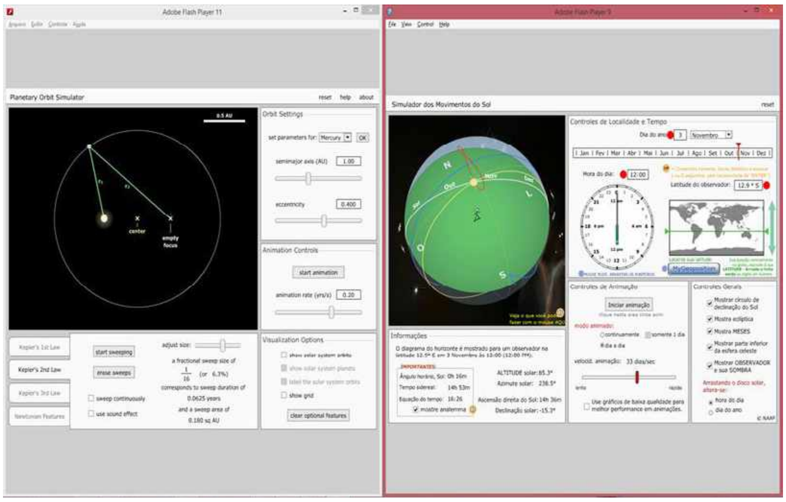

Figure 18: Simulators in the Position of ~ 11/ 03.

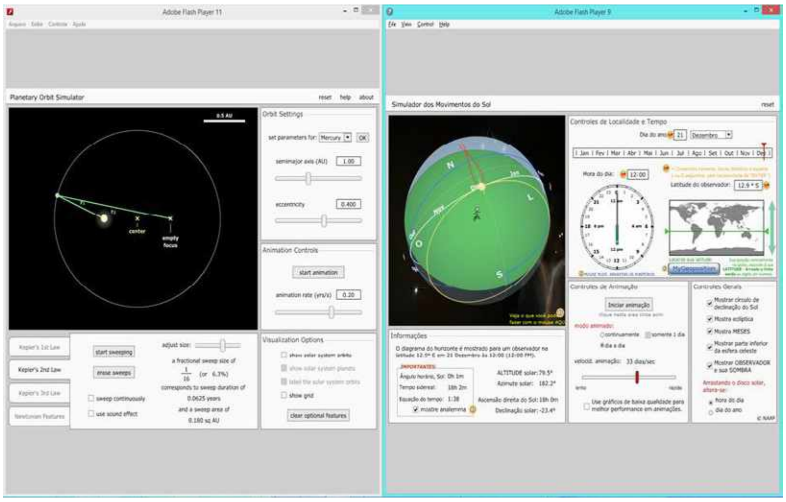

Figure 19: Simulators Again in the Position of ~ 12/21.

In the second simulator this date is after the southern solstice curve and the first simulator is perfectly to the left of our screen (Figure 10) until the date of the fast solar day of translation, ~02/12, the second simulator is demonstrated maximum east, halfway greater analemma, getting a little after perihelion, at the beginning of their “path” to the aphelion (Figure 11).

With this translation described and accompanied by simulators, it demonstrates the coincidence between the solstices and dates aphelion and perihelion. The perihelion occurs ~14 days after Southern solstice, while aphelia occurs ~14 days after the northern solstice (Figures 10 and 15).

When we say that the solar days have decreasing periods or “acceleration” and increasing periods or “deceleration” refer to the analemma while demonstrating chart [7].

For a better understanding, we will make the composition of aanalemma with four elements, two lines and two curves. Although the accuracy of the design is not tasteful, the arrows indicate its path correctly in each of the four parts, always taking into consideration the analemma as seen in the simulator (from heaven to earth). In analemma vision projected into the sky, to behold the earth, calendar positions would be reversed.

As the sun apparent movement is from east to west, every day the sun shines on a point of the analemma, is considered the same time for observation. Where it is located further at east, to say that the sun “walked a little,” that is, at the time of observation he has not advanced much, which can lead us to deduce that the sun is so slow that date or the planet is faster (since it varies its speed as Kepler/Newton). Similarly, on a certain date the sun was farther west, to say that the sun “walked a lot,” that is, at the time of observation he advanced a lot, which can lead us to deduce that the sun is then fast or that time the planet is slower.

As the arrows of the four elements that make up the figure indicate the correct direction of the sun’s path by the analemma, we can say, at times when it is in the two curves are times when it is going more and more to the east, it is presenting increasingly periods of lower solar days or, we can say with the license of Physicists, the solar days are "accelerating". In the times when it is in two straight lines, are periods of the year when it is going more and more to the west, that is, is presenting more and more periods of the largest solar days or we can say, again with the license of Physical solar days are "slowing down".

It is worthful remembering that the dates on which the sun is in the upper curve, with eastbound ("accelerating") are ~05/11 to ~07/25 (Figures 13-16) and the dates on which it is the bottom curve, also with eastbound ("accelerating") are ~11/03 to ~02/12 (Figures 9-11 and 18). However the dates when it is on the line pointing upwards with westbound ("slowing down") are ~02/12 to ~05/11 (Figures 11-13) and the dates on which it is on the line that points to down with westbound ("slowing down") are from ~07/25 to ~11/03 (Figures 16-18).

To help a little more the understanding and to allow a preview of the date of each paradoxical variations, below there is a figure with two diagrams. The red arrow indicates decrease in speed when it is in reference to the planet and increasing periods of solar days, when compared to the solar day [8]. Blue arrows serve to indicate the exact opposite, acceleration when referring to the planet and reducing periods when referring to the solar day. Of course by the allusion proposal, reducing solar days would be the "acceleration" of the same and increased solar days would be his "slowdown". Hence the use of the same color to these movements when referring to the planet (Figure 20).

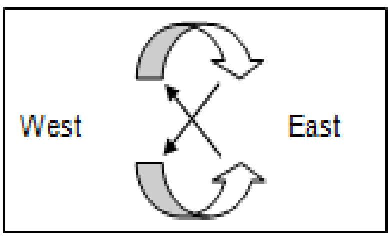

Figure 20: Analemma Composed of Four Elements.

Research

Measurements of the solar day periods were carried out with the aid of a fixed gnomon for determining the duration of a solar day and the results were documented in videos.

There are 16 videos that can be viewed on the internet with a simple search the title "Solar Day 01 Speed" to "Speed Solar Day 16". For each measurement there are two videos, one showing and doing the marking of the shade from the sun's position with a fixed gnomon, as described, on a certain date and at a certain time and another the next day showing what time it is when the sun passes the same point marked on the earlier date [9].

Thus, are also added to the titles of videos the words "departure" and "arrival" to signal that one is the day of the shadow position of marker and the following is to demonstrate what time is again passing through the same fixed point in planet.

The number 01 is played, made on 07/12/2012 and its full title is "Solar Day Speed 01/Departure 07/02/2012 14:45 (GMT)." The number 02 is of arrival, made on 07/13/2012 and its full title is "Solar Day Speed 02/Arrival 07/13/2012 14:42 (GMT)."

There is only one exception on the date of 08/27/2012, when it was made three starting videos (the numbers 03, 4:05) and the corresponding arrival, made the following date, 28/08/2012 leading the numbers 06, 07 and 08. Then, from nine to sixteen is always only one at a time corresponding to the arrival always the next day. We will avoid the transcription of all the titles not to enlargethe text so much [10].

The clock used is also available on the Internet with the official time of Brazil's capital, the city of Brasilia. The clock can be accessed at horariodebrasila.org address. We decided to use the same for a better reliability of the measurements, since they do not have a rigorous accuracy of seconds or fractions thereof, especially because they are spending a few seconds (about 08 or 10 seconds) for the displacement risk for paper made in document the position when a video of "departure" and similar time in the videos of "arrival" to get the brand to the clock on the Internet. The videos are generally for 40 seconds.

The poor accuracy, however, does not alter what we are demonstrating, which is a variation in the length of the solar day at the home of several minutes. The second simulation also shows that over time the outer analema demonstrates a difference in the amount of about 30 minutes, the data above the "analemma show". In ~11/03 hour angle of the sun features 16 minutes and ~02/12 presents -14 minutes. The poor accuracy do not alter the demonstration that is essentially a paradoxical variation of the solar day in relation to planetary motion.

To further ensure the usefulness of the measurements, a video was produced with a digital clock, this time placed next to the drawing board to the measurements, this video that is hosted on the same channel on a popular video site entitled "Method of accuracy", placed between videos numbers 10 and 11 and was published on 11/01/2012.

Recording begins at 14:07:30 and at that moment the shadow of the pointer is pointing precisely to the extent of 9.5 cm on the ruler affixed to the clipboard. The video is about two minutes and the camera goes behind the drawing board to demonstrate that they are all properly attached elements. When you are near the end, as you can see, the clock showing 14:09:30, two minutes flat, the shadow moves to the measure of 9.3 cm, which was approximately one millimeter for every minute.

Thus, it is attested total utility of measurements of this research, it would be impossible to fake a shadow passing the measure as this would only occur if they had passed several minutes. In short, the loss of a few seconds does not invalidate a measurement that only want to show that there is a variation more or less (and paradoxically) in periods of occurrence of solar days.

The measurements documented in the internet videos showed the following results:

- 07/12 and 13//2012 – 1437 min
- 08/27 and 28/2012 – 1440 min
- 10/08 and 09/2012 – 1441 min
- 10/29 and 30/2012 – 1442 min
- 12/03 and 04/2012 – 1441 min
- 01/ 07 and 08/2013 – 1439 min

So that the reader does not need to go back several pages to confront the figures, put down a analemma here with the schedule according to the display used by the simulator (top down to earth and not designed in the sky).

By observing the reader may notice that the first four are presenting increasingly longer periods, that is, are "slowing down", and are in line pointing west and the path going down, see explanations in decomposed analemma in the previous section. However the last two periods are presenting smaller and smaller, ie, are “accelerating”, under license of physics and are at the bottom of the analemma curve sector leading the path to the east [11].

We know that the day in summer lasts longer than the night and in winter the opposite occurs with respect to any one hemisphere of the planet. However, these differences are more perceived in temperate and polar zones. In the tropical zone, where the measurements were made, having the coordinates -13.00987 -38.51045, this time lag between days and nights on the dates of the solstices north and south are not very prevalent. For a viewer delays and tropical sun adiantosare more easily perceived than the difference of duration periods of days and nights (Figures 21 and 22).

Conclusion

The ellipse of the earth is almost round, with a low eccentricity, not showing, it is known, major deformities. The radius of the orbit to the sun is lower in the perihelion and aphelion greater. Perihelion to aphelion they are ever increasing. Aphelion to perihelion they are always decreasing. There are equidistant rays in two movements of “going” and “coming” so to speak, or both halves of the ellipse, if we consider that the aphelion and perihelion are highlighted spots. Certainly there are no discrepancies or completely different radii in different sectors of the orbit, which is in agreement with the previous observation. That’s right even if we use the simulator to greatly increase the eccentricity.

We can say that the earth only accelerates toward the perihelion or only slows down toward the aphelion. It happens that the periods of solar days do not exhibit this same behavior, since the dates indicated its variations periods (or speed) are exactly reversed.

We know that there is no disconnect between the speed of translation and rotation, they are related. As one increases, the other also increases, and decreases when, decrease together. The variations of the solar day, which in some dates of the year came with the system

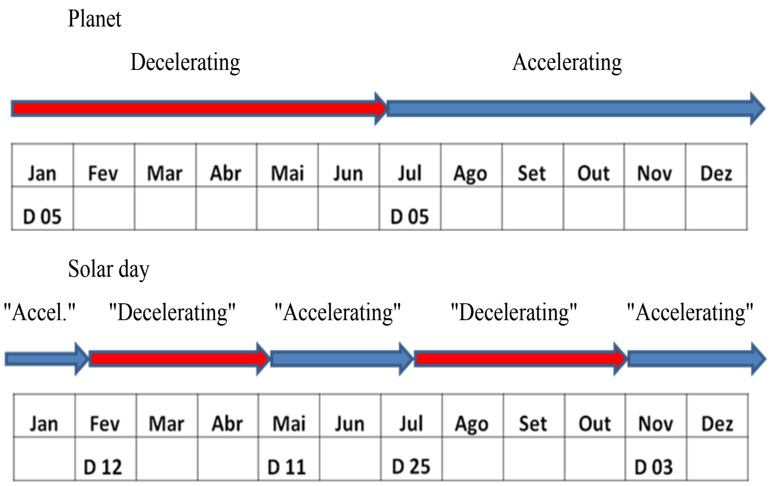

Figure 21: Comparison Between the Dates of Variations.

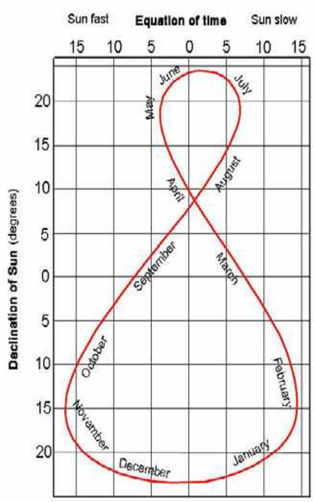

Figure 22: Analemma the Sun Seen From Above With Calendar.

Kepler/Newton, in other time periods behaves exactly the contrary, demonstrated graphically by variations of the analemma itself.

There are paradoxes because that solar days decreases their periods or "speed" between ~05/13 and ~07/25, which are the extreme dates of the analemma in the north (and among them are the northern solstice and aphelion, ~06/ 21/and ~07/05, respectively). Compared the rates of variations in solar days with changes in the world we see that the planet is slowing down to ~07/05. The same paradox occurs because the solar days increase their periods or decelerate between ~07/25 and ~11/03, and between those dates the planet is accelerating, given the law of universal gravitation.

The first date is the maximum position east of the northern analemma and the second is the maximum position west of the south analemma, that is, when it crosses the summit trend of "deceleration".

We know that the analemmais caused by two factors: The change in land speed in orbit (Kepler/Newton) and the slope of the imaginary axis of the planet. The greater the eccentricity of the orbit, the greater the east/west difference analema because of the greater difference in speed at different times during the year. The more inclined the axis, the greater the north/south differences. If there were alternating the speed of the planet and there was only the axial slope, the analemma would have a vertical line format. If there were no axial tilt and varying the speed or he would be a point. If there were no axial tilt and only had varying the speed it would be a horizontal line.

The interesting point is that the analemma describes paradoxes at the speed of variation of the solar day in relation to the variation of the velocity of the planet. The main curiosity is that if we score aphelion and perihelion dates in the analemma, we see that they occur almost perfectly about fourteen days after the two solstices:

Northern Solstice ~06/21/ aphelion ~07/05;

Southern Solstice ~12/21/ perihelion ~01/05.

Another interesting coincidence demonstrated by the analemma is that after aphelion the solar day "accelerates" only for a few days (~07/05 to ~07/25) and then enter the described paradoxical variation (of ~07/25 to ~11/03). Already after perihelion, it also still "accelerate" for a few days (~11/05 to ~02/12, which is also a paradoxical change), only to "slow" (now according to the speed of variation Planet) of ~02/12 to ~05/13. This is because the dates of the aphelion and perihelion, to limit the acceleration and deceleration of the planet, do not occur in the culminating dates analemma chart.

Another point worth mentioning is that the solar days are "slowing" the straights and "accelerating" in the curves. Straight are in low latitudes while the curves are in the higher latitudes. As we have seen, the dates of the solstices are the curves, as are the high points of the analemma and aphelion and perihelion dates are after them.

Considering the analemma graph condition and taking into account the sun's apparent motion on the planet takes place from east to west, the further east the sun shines at the same time, the slower the solar day is, since the sun " walked a little "on the map. The more west, faster, for similar reasons. The news is that not always the sun is slow because the planet is fast and not only the sun is fast because the planet is slow, given the paradoxical variations identified.

References

1. Niu MCY (1989) Airframe structural design. Practical design information and Junior A, Sampaio L (2014)The Theory of Solar Zenith: a proposal for the seasons in inter-tropical locations. Salvador Edufba.
2. Junior A, Sampaio L (2014) VPPDDSRSKN.
3. GabrielKuhnB. The spatial part of human time.
4. Google Earth.
5. Konstanta (2015) Analemma.
6. (2015) Nebraska Astronomy Applet Project - NAAP. Sun Motions Demonstrator. University of Nebraska-Lincoln UNL.
7. Nebraska Astronomy Applet Project - NAAP. Sun Motions Demonstrator. University of Nebraska-Lincoln - UNL. (Translated and Adapted version).
8. Filho O, de Souza K, Saraiva, Maria de Fátima Oliveira (2014) Time measures.
9. Filho O, de Souza K, Saraiva, Maria de Fátima Oliveira. Motion of the planets: TychoKepler and Galileo.
10. Rumyantsev V. Crimean Astrophysical Obsevatory.Analemma.
11. (USNO) United States Naval Observatory, The United States Naval 3450 Massachusetts Ave, NW, Washington, DC20392-5420.