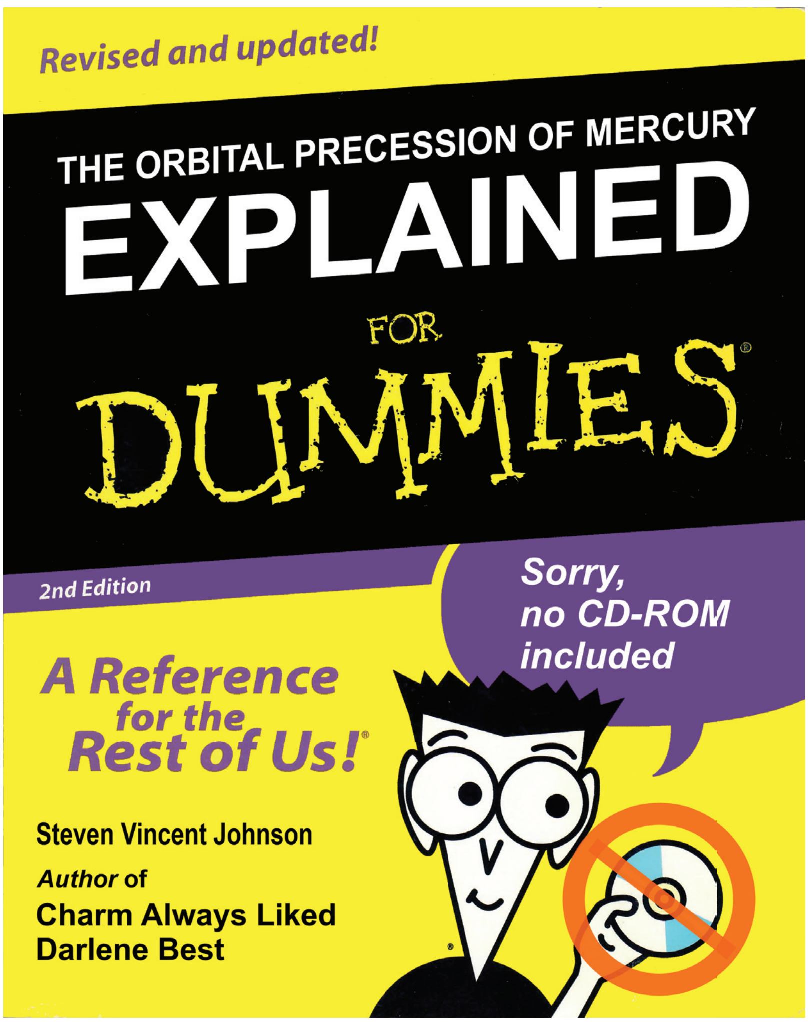
Sonova Quark

Brought to you by Steven Vincent Johnson and Darlene P. Coltrain, mailing address: 6666 Odana Road, #213, Madison, WI 53719. Email Steve: orionworks@charter.net. Email Darlene: dpcoltrain@gmail.com Web: http://OrionWorks.com. All material is Copyrighted © by Steven Vincent Johnson and Darlene P. Coltrain unless otherwise specified. Quark is brought to you by *OrionWorks*. Internal layout is assembled in InDesign CS5. Printing done on a HP Color Laserjet Pro MFP M277dw. Most covers were created using CorelDraw graphics suite and printed on a Cannon PRO-100 Photo Inkjet printer.

This edition was created for ***Turbo Charged Party Animal***, #408
Completed somewhere around the date of June 21, 2020

Turn, Turn, Turn

The Sequel



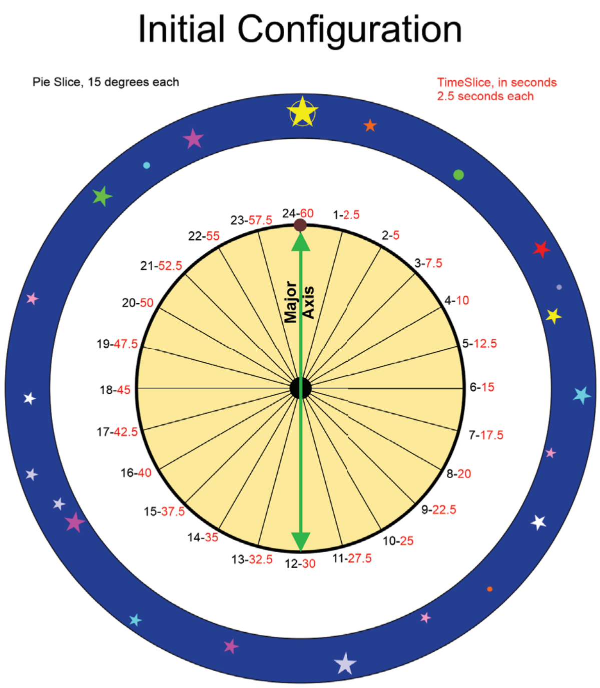
Available in most book stores!

Why does Mercury precess in its orbit around the sun? Precise measurements assembled over the century revealed the fact that the innermost planet precesses forward in it's elliptical orbit around the sun by about 5600 arc seconds per century. That comes to around 1.5 degrees per century. Classical physics involving tenuous gravitational pulls of nearby planets like Venus and Earth did a good job of explaining 5557 seconds of precession. But that still left 43 arc-seconds unexplained. All sorts of creative explanations were brought forth, including daring conjecture that there must exist another planet (named Vulcan) orbiting even closer to the sun than Mercury. Unfortunately for the Vulcan believers no credible observations of the hypothetical planet have ever been observed. Then along came Einstein. He looked at the measurement discrepancy, and applied his theory of Relativity to Mercury's orbit. Miraculously, the unexplained discrepancy of 43 arc seconds became explainable. We tend to assume that we, the common folk, cannot grasp the intricate geometry involved. *NOT TRUE!* The following article reveals the geometry involved combined with the effects of time dilation for which I hope rest of us dummies will be able to Grok in all its wonder.

We begin with an application of the KISS principle.

Lets pretend we have a planet orbiting a black hole so closely that the effects of Relativity are distinctly noticeable to outside observers not under the influence of the black hole's gravity well. Consider the movie *Interstellar* as an example involving a planet circling a black hole, named Gargantuan. The effects of time dilation resulted in several astronauts travelling to the planet's surface to experience each hour of haplessly floundering about and not accomplishing much of anything as the equivalent of seven years of useless boredom as experienced by another unfortunate astronaut who volunteered to remain the mother ship outside of the influence of the massive black hole's gravitational well.

We begin our measurements of the geometry involved by employing a planet possessed with a perfectly circular orbit. Let's assume our planet should complete its circular orbit every 60 seconds. Without question, this is a very fast moving planet!



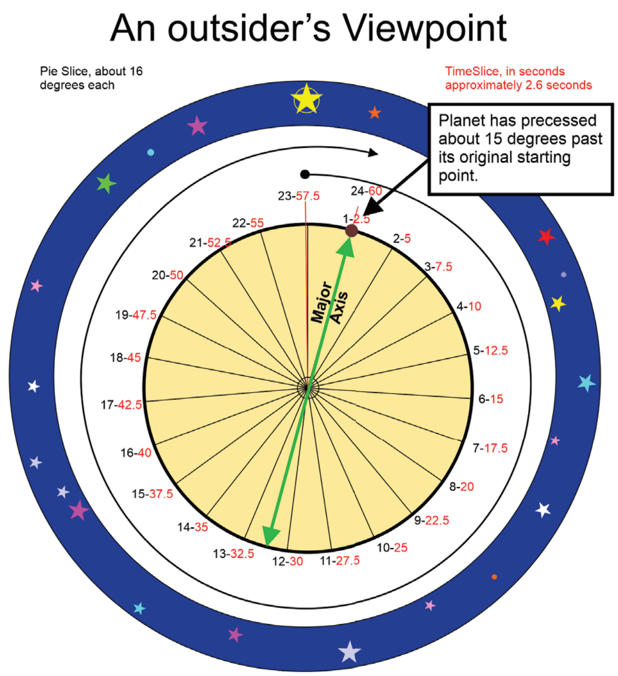
Kepler's 2nd law states a line joining the Sun and a planet sweeps out equal areas in equal times

According to **Kepler's 2nd Law**, each "pie piece" possess the same area. Each segment sweeps out in 15 degree increments. It takes the planet 2.5 seconds to traverse from one 15 degree "pie slice" to the next "pie slice". Adding up the time slices of all 24 segments results in 60 seconds.

fig 1

We pre-calculated how long it should take to complete an orbit via Newton's mathematical formulas involving the force of gravity distilled down to the equation: $1/r^2$. We will also took advantage of Kepler's 2nd law which states:

> A line joining the Sun and a planet sweeps out equal areas in equal times



Kepler's 2nd law states a line joining the Sun and a planet sweeps out equal areas in equal times.

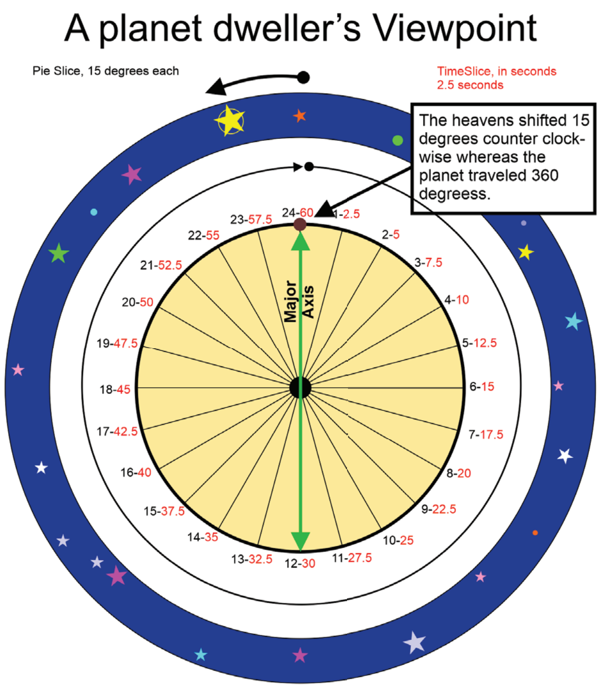
However, according to **Kepler's 2nd Law**, something seems amiss! While each "pie piece" may possess the same amount of area. Each segment sweeps out in approximately 16 degree increments. Because of Time Dilation it takes the planet approximately 2.6 seconds to traverse from one 16 degree "pie slice" to the next 16 degree "pie slice". This results in the planet not ending up where it started. It ends up approximately 15 degrees past the original starting point..

fig 2

...which reveals to us the fact that every "pie slice" is an equal slice of time. We also place a highly accurate atomic clock on the surface of the planet so that we can measure where the position of the planet will align itself up with when 60 seconds are up. (See fig 1)

Let the spin begin!

Our planet traveling at close to the speed of light, as perceived by an outside observer notices a time dilation due to Einstein's theory of Relativity. The atomic clock has slowed down by a noticeable



Kepler's 2nd law states a line joining the Sun and a planet sweeps out equal areas in equal times

To an observer standing on the surface of the planet, **Kepler's 2nd Law**, was scrupulously obeyed. Each segment is observed to sweep out in 15 degree increments taking 2.5 seconds to traverse from one 15 degree "pie slice" to the next "pie slice" However, the heavens appear to have shifted counter-clockwise by 15 degrees.

fig 3

amount. An outside observer notices that the clock does not register 60 seconds until the planet has travelled not just 360 degrees, but a total of 375 degrees, a complete 360 rotation plus 15 extra degrees. (See fig 2). Said differently, while outside observers may believe that 60 seconds must have transpired, the atomic clock states, unequivocally that only 57.5 seconds have transpired. Meanwhile, planet dweller will notice the curious fact that the outside Universe appears to have shifted clockwise by 15 degrees when the clock finally registered 60 seconds.

One might argue we're talking apples versus oranges as to what comprises a complete 360 degree orbit since wouldn't an outside observer be compelled to conclude that the orbit completed 360 degrees in 60 seconds even though the atomic clock claims to read 57.5 seconds. Maybe the atomic clock is faulty and playing tricks on the planet dweller's perceptions. (See fig 3) Such an argument might have gotten some traction if it were not for the fact that had the same planet possessed an elliptical orbit the clock would show 60 seconds only after the planet has precessed well PAST the beginning point of where the first time measurement had been logged.

Going from circular to elliptical orbits.

How would an elliptical precession map out? To ease our perceptions into making the jump from a perfectly circular orbit to an eccentric one I will first engage in a brief bit of historical gossip. Also included are a number of rote-like diagrams which I confess some readers may find repetitious. First, we need to analyze the significance of what Kepler's 3rd law states:

> The ratio of the squares of the orbital period for two planets is equal to the ratio of the cubes of their mean orbit radius.

Did you understand the above statement? I sure as hell didn't when I first read it! I didn't understand its significance for decades! The wording, involving the squaring and cubing various orbital artifacts. Well.. shoot! It stuck me as so obtuse that I immediately avoided any and all attempts to make sense of it. It only started making sense after I had innocently (and most naïvely I'll add) conducted a series of computer generated orbits involving different elliptical eccentricities and orbital periods. Only then did I begin to realize a significant problem exists with the current wording. It's significance is so turgid that it guarantees few will *feel sufficiently motivated in discovering a far less turgid significance of what the law reveals*. During my computer simulation work, I discovered the fact that if I kept the orbital time period constant while varying the orbit's eccentricity... out popped another distinct constant value. Better yet, neither constant needed any kind of sophisticated squaring or cubing to, in effect, divine their significance. This is what I discovered:

> While maintaining a fixed orbital period while varying the orbit's eccentricity the major axis of the elliptical orbit remained a fixed constant as well.

In truth, this revelation (which I blundered into all on my own) has been dutifully documented in the fine-print involving descriptions of Kepler's 3rd law. You can find an equivalent of the above description written out in Wikipedia. The reader, however, needs to possess sufficient fortitude and patience to wade through techno-speak before the above revelation is revealed. Perhaps I'm guilty of being

The Complicated Wording of Kepler's 3rd Law,

Explained With Some Difficulty

Kepler's third law states that ***the ratio of the squares of the periods divided by the cubes of their average distances from the sun produces a constant value that remains pretty much the same for every planet in our solar system.*** But why does this orbital period, squared (See third column) divided by the Average Distance the planet is to the sun, cubed (See fifth column) result in a nearly constant value (see column six)? While the resulting constant value may indeed be interesting to most scholars, why this constant value regularly crops up is not obvious nor readily understandable at face value. That is because the 3rd law, as it tends to be described and currently taught is rarely distilled down to its most basic and elementary essentials which, if properly distilled, would immediately explain why this mysterious constant value crops up.

Planet	Period in Earth Years	Period (T)	Average Distance (major axis)	Average Distance (R)	T^2/R^3
	(yr)	(squared)		(cubed)	(yr^2/au^3)
Mercury	0.241	0.058081	0.39	0.059319	0.98
Venus	0.615	0.378225	0.72	0.373248	1.01
Earth	1	1	1	1	1
Mars	1.88	3.5344	1.52	3.511808	1.01
Jupiter	11.8	139.24	5.2	140.608	0.99
Saturn	29.5	870.25	9.54	868.250664	1
Uranus	84	7056	19.18	7055.792632	1
Neptune	165	27225	30.06	27162.32422	1
Pluto	248	61504	39.44	61349.45638	1

A constant value of 1, or close to 1 is generated in all cases.

fig 4a

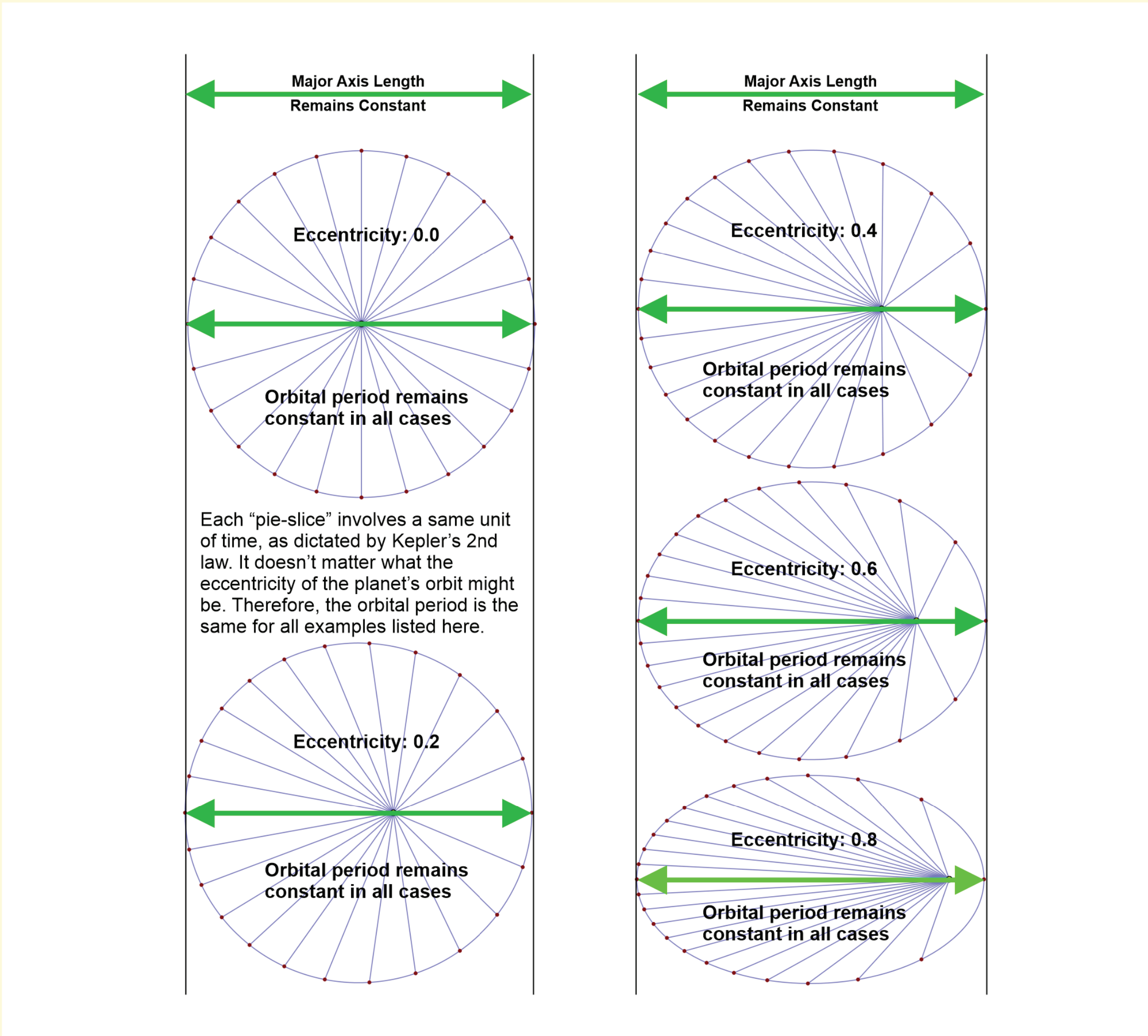
overly subjective but it seems to be mentioned as if it is nothing more than an interesting curiosity. It is implied that this finding is a result how the 3rd law is currently worded. I find myself objecting to such a conclusion. IMHO, the exact opposite would be far more accurate. I think the current wording of Kepler's 3rd law is, itself, a direct consequence to the fact that *if one maintains a fixed orbital period while varying the eccentricity of the orbit the major axis of the elliptical orbit remains a fixed constant.* Stated in more practical terms, it is *NOT* just a curious after-thought.

I suspect Kepler was most likely not aware of this curiosity. If he had been aware of the existence of these two constant relationships I think it likely that he would have revised the wording of the 3rd law, perhaps in significant ways. I think it likely that he would have incorporated and built on the observations for which these two constants richly reveal. The result might have been that the more turgid wording we now know as Kepler's 3rd law would have been written up in the history books in a more direct and easier to understand way.

In no way am I attempting to place blame on Kepler for the ensued obfuscations I perceive he introduced. It is not his fault for the simple reason that Kepler did not have at his disposal luxuries, such as a personal computer that would have allowed him

In an ideal world, Kepler's 3rd Law - Simplified

Ideally, Kepler's 3rd law would make more sense if it had been written to initially focus on the fact that if one maintains a constant value for the orbital period while changing the eccentricity, the length of the orbit's major axis will also maintain a constant value.



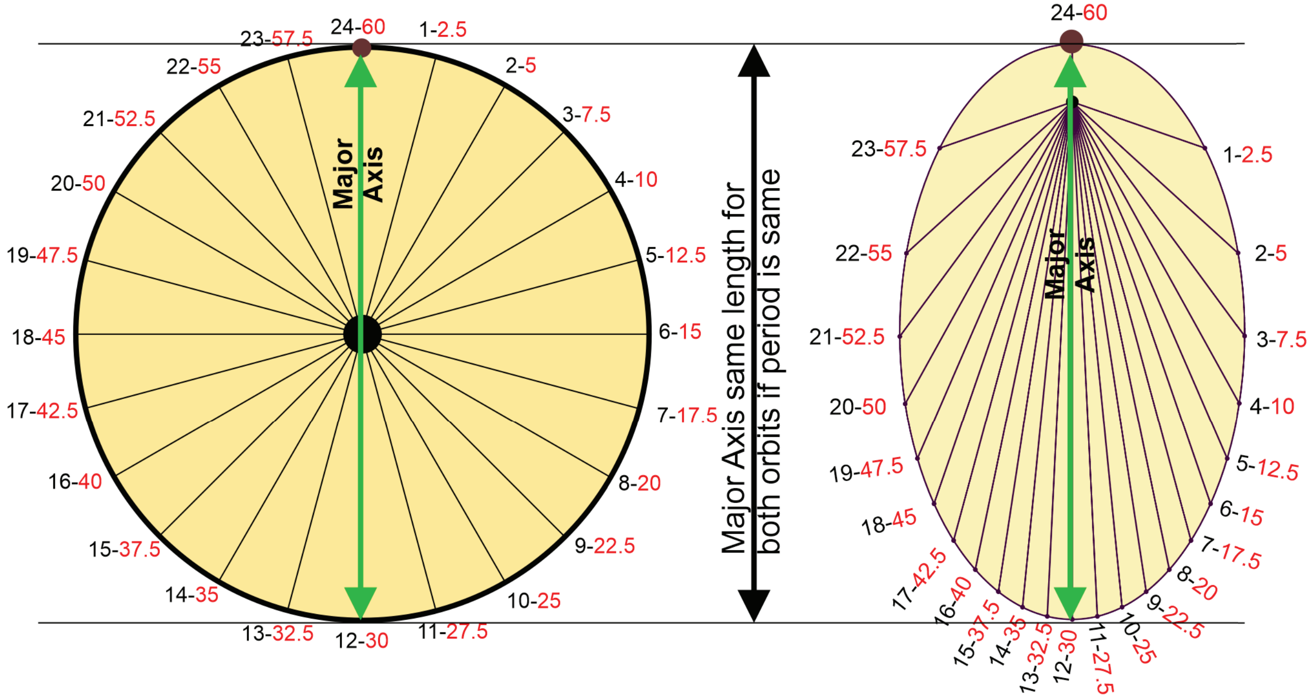
The major axis remains the same no matter what eccentricity, including zero eccentricity, is used. One of the major advantages of adopting a simplification of the wording would be the fact that it gets rid of having to use a squared value of the orbital period divided by a cubed value of the planet's average distance to the sun... all this in order to produce a mysterious number that is nearly constant. Instead, two immediately perceived constant values (the planet's orbital period and the planet's major axis), pop out in full view. In my view, the simplified geometry not only immediately reveals more crucial information, it better explains the reasons behind why the complex mathematical configurations and ratios manifest, mysteriously so, in the current wording of the 3rd law.

fig 4b

A Tale of Two Eccentric Orbits

Eccentricity of 0.0
a perfect circle

Eccentricity of 0.8
a noticeable ellipse



If each of the 24 "pie-slices" with equal area (Kepler's 2nd law) take 2.5 seconds for a planet to traverse, the orbital period for this elliptical configuration (with an eccentricity of 0.0) will take 60 seconds to complete a full orbit. Also note the Major Axis length is the same.

Therefore, if each of the 24 "pie-slices" belonging to this elliptical orbit (with an eccentricity of 0.8) takes 2.5 seconds to traverse, it also takes 60 seconds to complete a full orbit. Also note the Major Axis length is the same.

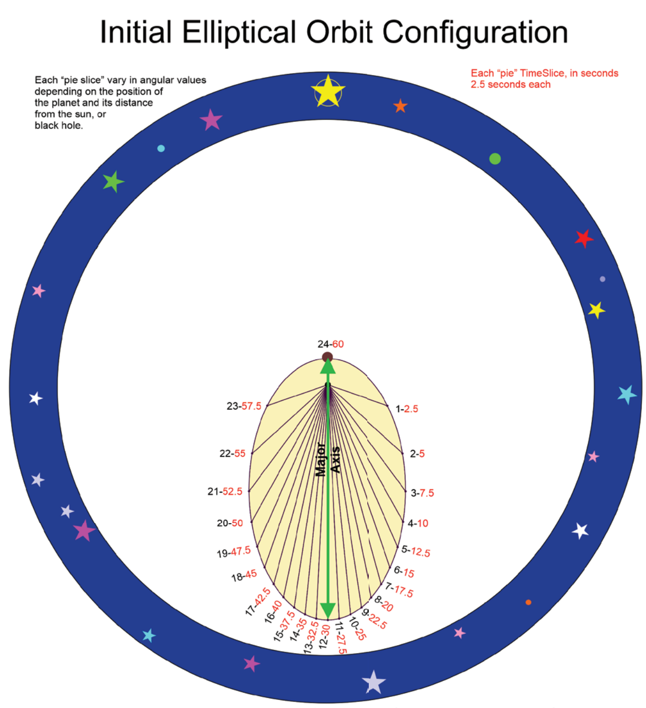
Kepler's 3nd law infers that if all hypothetical orbits involving the same planet (or satellite) are made to maintain the same orbital period, where only the eccentricity of the orbit is allowed to vary, the Major Axis length for all hypothetical orbits will remain the same.

fig 5

to crunch through endless simulations of eccentric orbits and orbital periods. Also, Newton hadn't yet been born to mathematically formulate a force called gravity, a famous equation describing Force as:

$$1/r^2$$

Lastly, in Kepler's time the crucial development and subsequent study of velocity vectors had not yet been quantified in practical mathematical ways. All Kepler had in his possession was a highly accurate table logging the plotted positions of Mars' orbit which by all accounts he had to clandestinely abscond with when Tycho Brahe, the creator of the



Kepler's 2nd law states a line joining the Sun and a planet sweeps out equal areas in equal times

In our example, following **Kepler's 2nd Law**, each "pie piece" possess the same area. Each of the 24 segments sweep out in 2.5 seconds totaling 60 seconds to complete a full orbital period.

fig 6

Martian table, died. Kepler discretely lifted the logs from Tycho's study in order to prevent in-laws from getting their hands on them. Kepler, perhaps with justification, feared their accessibility and historical significance would likely have been far less assured, particularly when it came to where Kepler's own research efforts were concerned. Setting my petulant criticisms aside, what Kepler managed to accomplish with just a table of Martian position plots remains, in my view, the mark of absolute genius.

Applying Relativity and Time Dilation to the mix

I cannot repeat enough times the importance of the fact that:

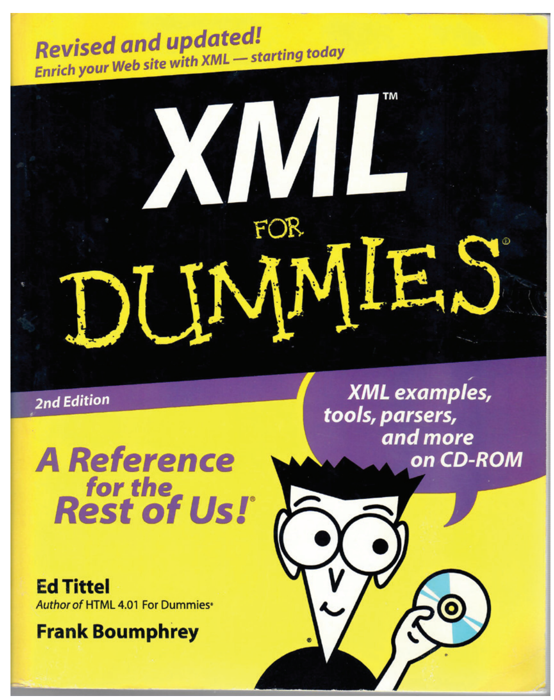
> If the orbital period remains fixed while adjusting the eccentricity of the orbit the major axis of the elliptical orbit remains a constant as well.

This law allows us the convenience of switching out a perfectly circular orbit experiencing the influence of Relativity and Time Dilation with a different elliptical orbit possessed with an equivalent orbital period and major axis. See figs 7 and 8 on how the effects of Relativity and Time Dilation produce pretty much the same orbital precession even though at first glance it might not seem to be the case. What I hope the reader ultimately takes away from a closer study of figures 7 & 8 is the fact that Kepler's laws, and probably Newton's laws as well, are NOT being violated. The laws only appear to be violated from the viewpoint of outside observers who are not being influenced by Relativity and Time Dilation. But for inhabitants standing on the surface of a planet experiencing the influences of Relativity and Time Dilation, Kepler's laws (and possibly Newton's laws as well) remain faithfully intact.

I bring this discrepancy up because in my reading experience contemporary literature on the matter tends to describe the combination of Kepler and Newton laws as no longer applicable or accurate when the influences of Relativity and Time Dilation must be taken into account. In my opinion, that is a rather narrow-minded conclusion to make, and I disagree with it. From my point-of-view, it's all relative!

OW

BTW… This is what I used in a blatant act of plagiarism while assembling *The Orbital Precession of Mercury Explained for DUMMIES* cover:



How the elliptical orbit and the surrounding universe is perceived by a stationary individual standing apart from the influences of Time Dilation caused by General Relativity.

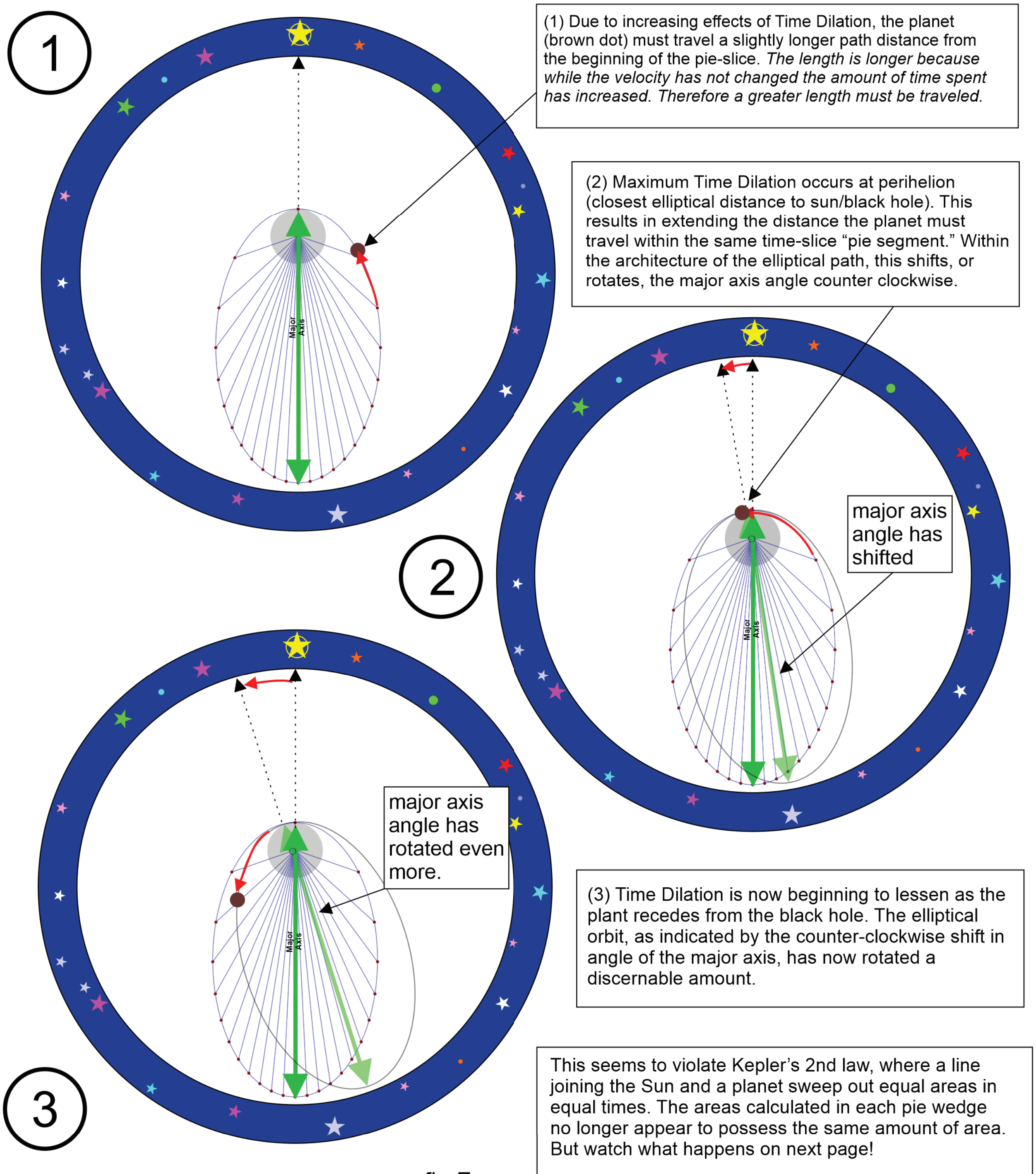
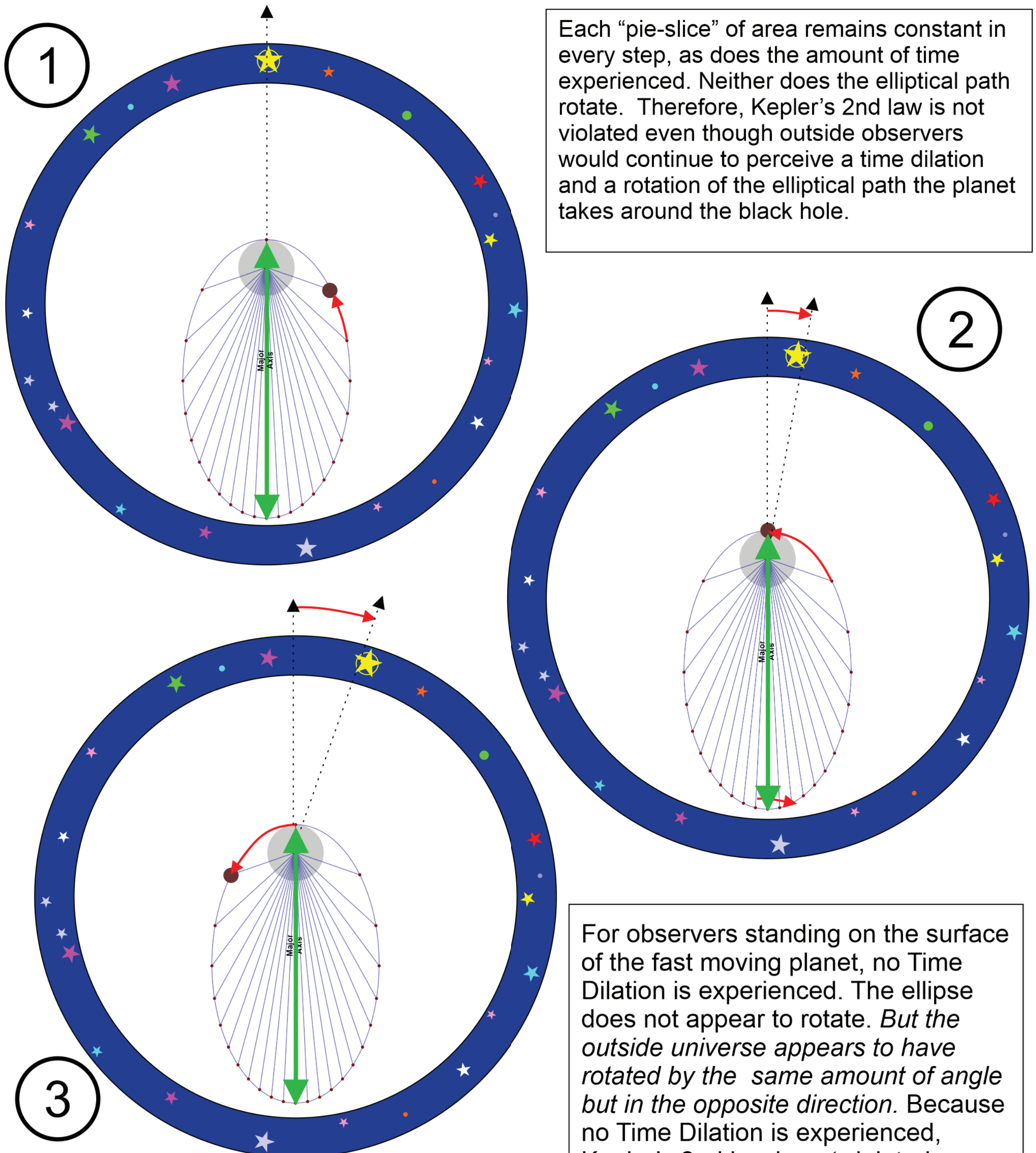


fig 7

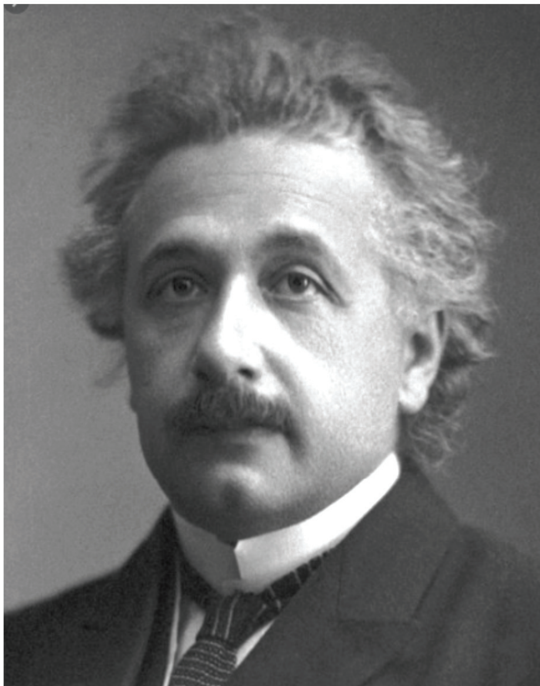
How the elliptical orbit and the surrounding universe is perceived by an individual standing on the surface of the planet being affected by Time Dilation caused by General Relativity.

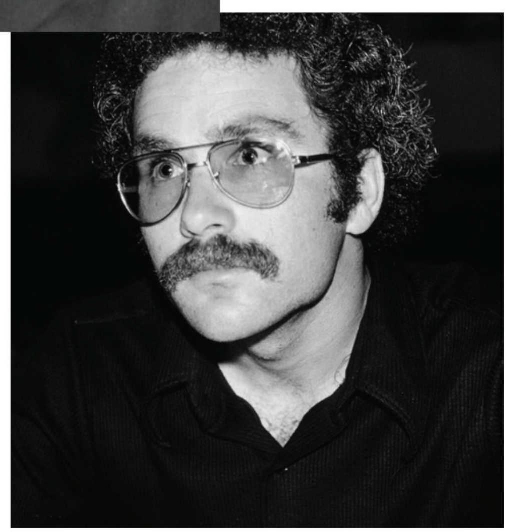


Each “pie-slice” of area remains constant in every step, as does the amount of time experienced. Neither does the elliptical path rotate. Therefore, Kepler’s 2nd law is not violated even though outside observers would continue to perceive a time dilation and a rotation of the elliptical path the planet takes around the black hole.

For observers standing on the surface of the fast moving planet, no Time Dilation is experienced. The ellipse does not appear to rotate. *But the outside universe appears to have rotated by the same amount of angle but in the opposite direction.* Because no Time Dilation is experienced, Kepler’s 2nd law is *not* violated.

fig 8





Did I get it right, Albert?

Let me sleep on it.