Sonova Quark

Brought to you by Steven Vincent Johnson and Darlene P. Coltrain, mailing address: 6666 Odana Rd. Madison WI 53719. Contact by Mail: Steve: Orionworks@charter.net, Darlene: dpcoltrain@gmail.com. Sonova Quark is brough to you by OrionWorks. Internal layout is brought to you by Microsoft Publisher. Printing done on a HP CVolor Laserjet Pro MFP M277dw. Most color 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

Can the Red Wavy Line Help Explain Orbital Mechanics?

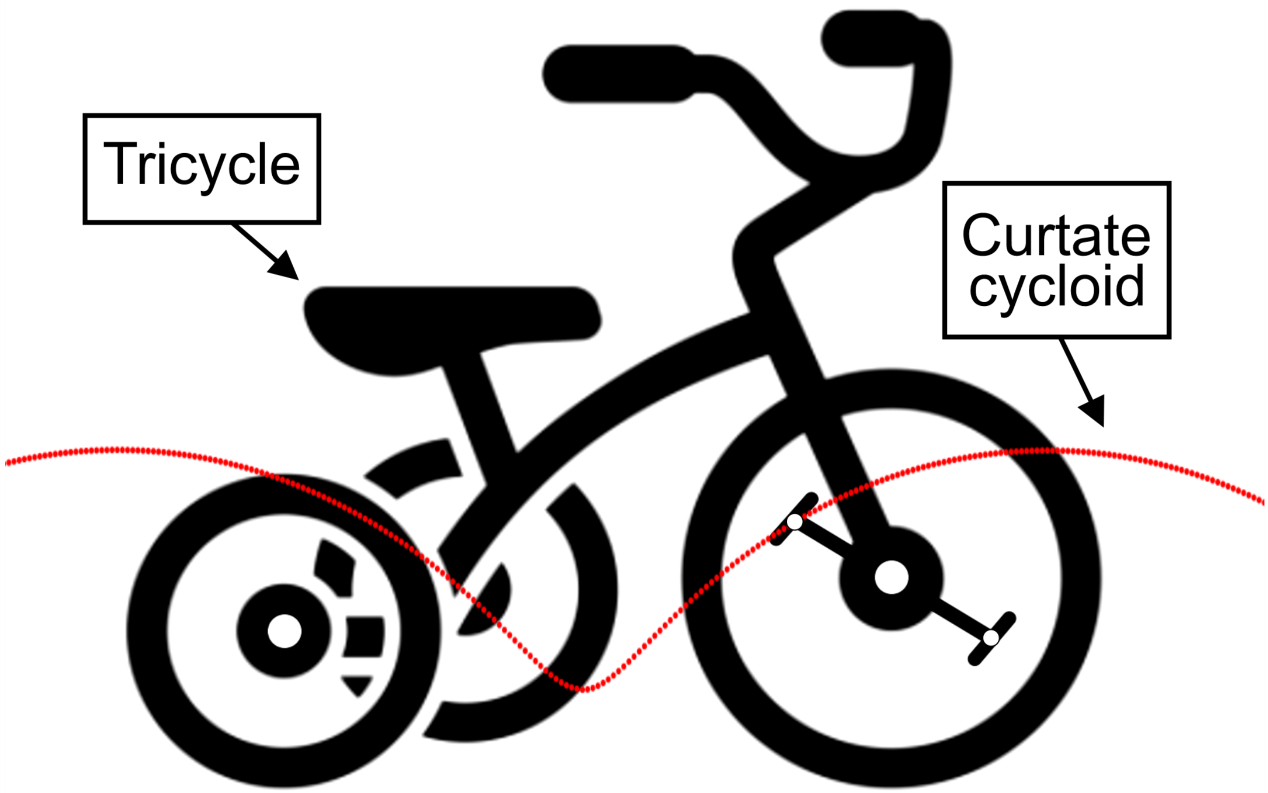
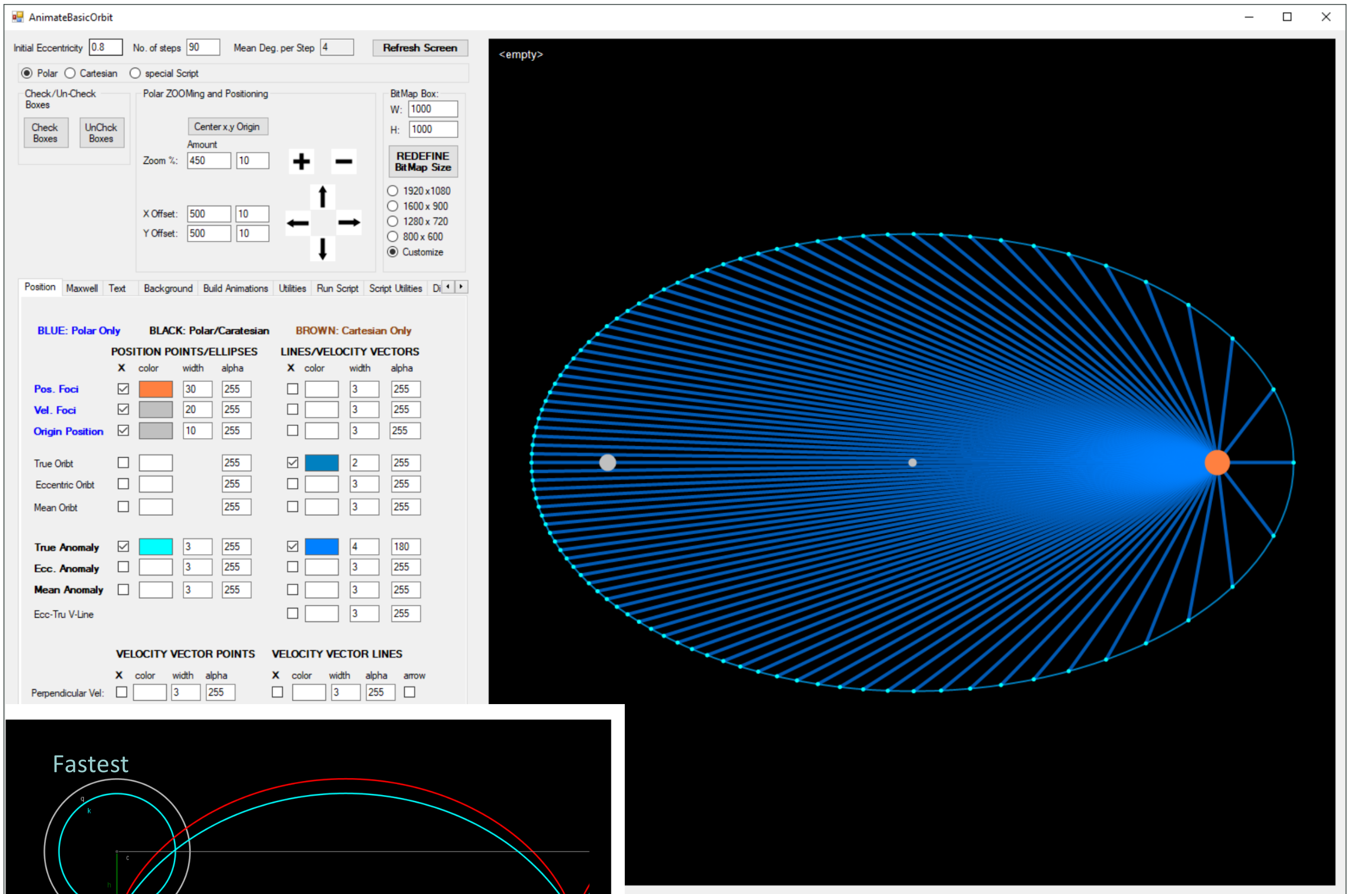


Fig 1

Another Orbital Mechanics Update

Can a peddle attached to a moving tricycle wheel explain the mysteries of Orbital Mechanics? Yes, Virginia, it can! But to truly reveal its elegance the subject should be animated. I have already done this. Watching one of these animations and grokking what's happening would likely take an observer no more than ten seconds, tops. Alas, Turbo still lurks somewhere between the luddite realms of papyrus and inkjet. Therefore, I will endeavor to reveal a few of the more interesting revelations the old fashion way with the help of screen shots, *Microsoft Publisher*, and *Corel Draw*.

Read on, and may you find a moment of clarity



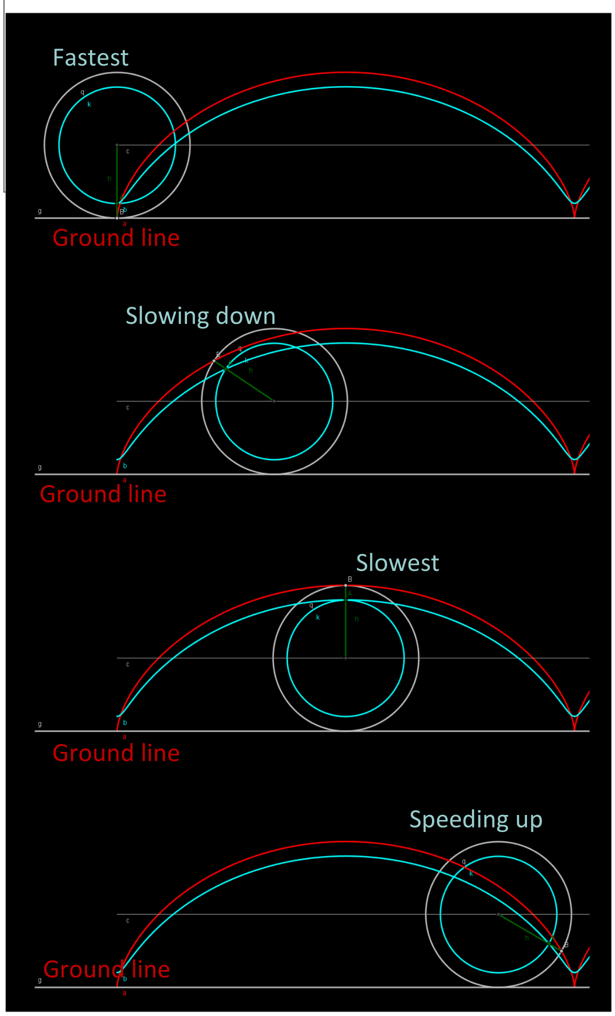


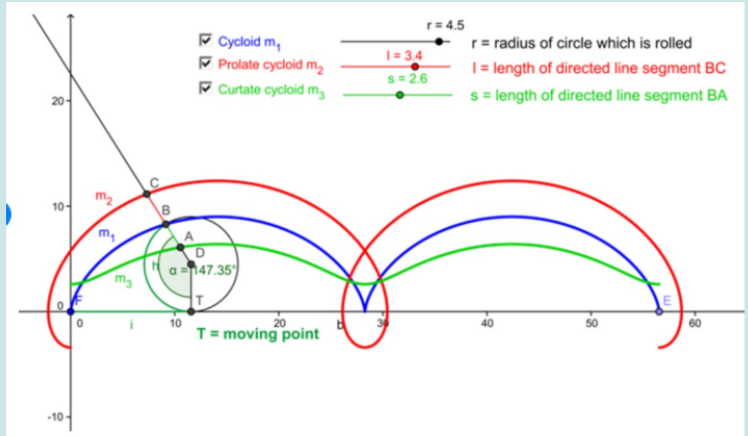
Fig 3, Two invisible "peddle" wheels

Fig 2: A screen shot showing one of my computer screens.

The two graphics depicted on this page (fig 2 & 3) are assembled screen shots generated from one of my computer animations written in c#. Some TURBO members might recognize Fig 2 as a close representation of a previous TURBO cover I contributed back in 2018. See fig 5, page 4 for a reminder.

The radiating blue lines shown in fig 2 represent the distance a hypothetical planet travels around its parent star in equal area/time segments. (Kepler's 2nd Law.) I represent the star as an orange dot fixed at one of two foci within the ellipse. (Kepler's 1st Law.) Notice that the blue lines near the sun are spaced further apart (meaning the planet is moving faster) than the lines farther away from the sun. The physics of why a planet speeds up and slows down follows the same laws as depicted watching a slowly spinning ice-skater as she gracefully retracts her arms and legs resulting a dizzyingly fast spin.

The four assembled animation images (fig 3) represent two more circles, one smaller and centered inside the other. Consider them invisible but connected to the tricycle wheel at one of the peddle axis. They represent the motion and path of the tricycle peddle and the outer tire circumference of the visible wheel. Keeping these invisible circles in mind, visualize the *visible* tricycle wheel as moving from left to right *at a constant speed*. The blue line (fig 2) depicts the position of a planet's orbit using *polar coordinates,* where vertical "y" lines radiate out from a fixed origin point like the spokes of a bicycle wheel. Meanwhile, the blue lines (fig 3) depict the same distance of the planet from it's parent star but represented in traditional *cartesian coordinate* fashion, not polar. Unfortunately, with static images, it's difficult to appreciate the fact that while the tricycle wheel moves at a constant speed the *invisible* wheels (fig 3) speed up as the blue and red lines get closer to the ground and slow down when the blue line reaches maxim distance from the ground. *This is because the connecting rotating axis between the tricycle wheel and the invisible wheels are not positioned at the center of the tricycle wheel but at one of the pedal's axis.*



Cycloidal motion and examples of cycloids. Cycloid (blue), prolate cycloid (red), curtate cycloid (green).

For those who might be curious, the provenance of the wavy red and blue lines (See fig 3) were discovered by mathematicians a long time ago. The blue line, the most well-known of the three, is called a ***cycloid***. The less common lines (red and green, are called *Prolate cycloids* (red) and *Curtate cycloids* (green) respectively. Trigonometric equations easily generate these wavy lines through the simple magic of parametric equations. To the best of my knowledge no mathematician as ever considered employing *Curtate cycloids* to plot the elliptical path and position planets take as they orbit their parent star.

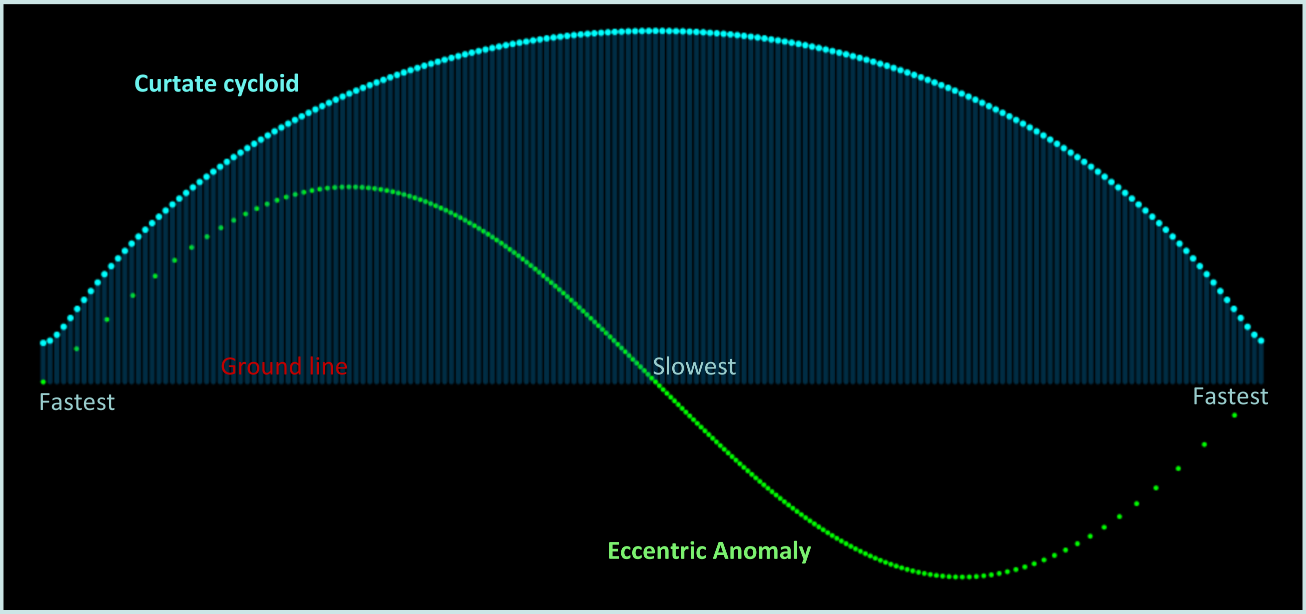
Fig 4: Screen shot off the Internet on the subject of Cycloids

If we migrate the axis of the tricycle wheel outward towards the circumference of the wheel, an off centered distance, and if that peddle offset axis maintains a constant horizontal speed matching that of the visible tricycle wheel, the peddle axis (and invisible wheel) is forced to wobble up and down, and speed up and slow down in the horizontal direction. This produces a roadmap allowing us to mechanically plot the positions a planet takes as it travels an elliptical orbit around the parent star.

I realize it's nearly impossible to visualize with static imagery. Perhaps that is why, at least to the best of my knowledge, this geometry may have never been discovered. The closest artifact I have come across is the highly studied 2000 year old Greek *Antikythera mechanism*. (Fig 7) It's considered the oldest mechanical computer ever discovered. The device accurately plots the moon's position and other nearby planets based on a Geocentric earth-centered universe. Like my tricycle peddle, the Greeks even used an off-centered axis for one of the gear wheels to more accurately plot the orbital positions of the Moon circling the Earth. I'm certain a revised mechanical analog computer could be constructed, perhaps in honor of the Greeks *Antikythera mechanism*. The new version would display the positions using a pre-determined *elliptical* path. It would be based on a Heliocentric Universe, where the sun is considered the center.

Last, but not least, on page 4 (fig 6) you might recognize additional geometry associated with the *Curtate cycloid*. It is represented by the blue dotted "line". Now, look at the green dotted "line". It represents the *Eccentric Anomaly*. (*Eccentric Anomaly?* Don't worry about it.) It depicts a typical sine wave—a perfect circle. Notice that while the vertical lines connecting up with the blue dots appear to be equally spaced, the *Eccentric Anomaly* "line" of green dots are not equally spaced. They are spaced farther apart where the "line" of blue dots move down approaching the ground line. They grow gradually grow closer together where the blue dots move up and farther from the ground line.

The green "line" represents the *invisible* wheel associated with the rotating tricycle peddle. While seemingly counter-intuitive, the *invisible* wheels move more quickly near the



The blue dotted "line" depicts another *Curtate cycloid*. The green dotted "line" depicts a typical sine wave. The "line" of blue dots appear to be equally spaced from each other from left to right. Meanwhile, the green dotted "line" appear farther apart from each other when the blue dots are close to the ground line. The green dots gradually grow closer together where the blue dots are farthest from the ground line. Remember the *invisible* tricycle wheel moving back and forth, moving faster and slower based on where the offset peddles' axis was positioned? If you make the horizontal spacing of the blue dots mimic the varying spacing of the green dots, you can exploit the resulting geometry in a manner that accurately traces out where a planet's position would be plotted on its elliptical-orbital path around the parent star. To the best of my knowledge this has never been done.

Fig 6: Another one of my animation screen shots

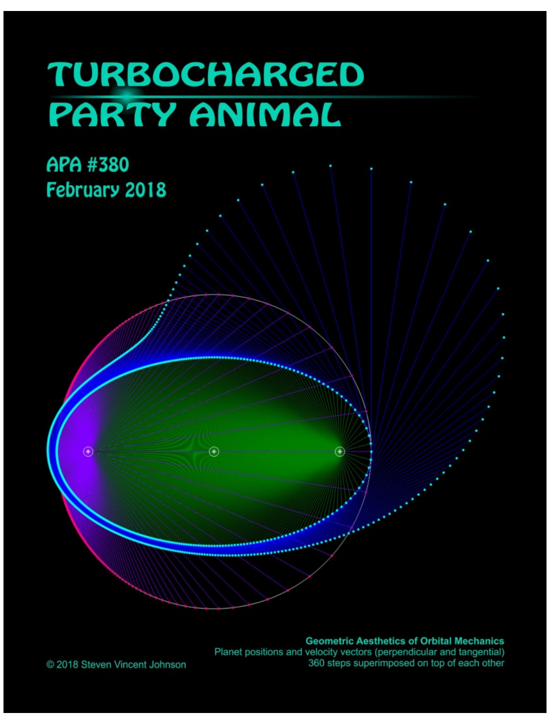


Fig 5: TURBO February 2018

ground line and slower the farther away they are from the ground line. Additional geometry (which I mercifully left out to simplify things) shows us how all this geometry, together, is connected allowing us to plot, *mechanically,* a planet's elliptical path.

Maybe I can eventually interest UW Mechanical Engineering department in assembling a 3-d printed mechanical computer, a modern updated Antikythera device. Perhaps developing the mechanics would make a good seniors or graduate project. Depending on the amount of interest generated, maybe competitions could be developed to see which team comes up with the most elegant design.

Ok! Enuf about *Curtate cycloids*! I hope some of you enjoyed some of the wavy lines my computer code generated. I did!

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Fig 7
Antikythera Mechanism