

ASTR 2310: Chapter 2

- *Continuing..*
- Galileo: The First Modern Scientist
- Kepler's Laws of Planetary Motion
- Proof of the Earth's Motion

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- Galileo: The First Modern Scientist



- A legend, of course

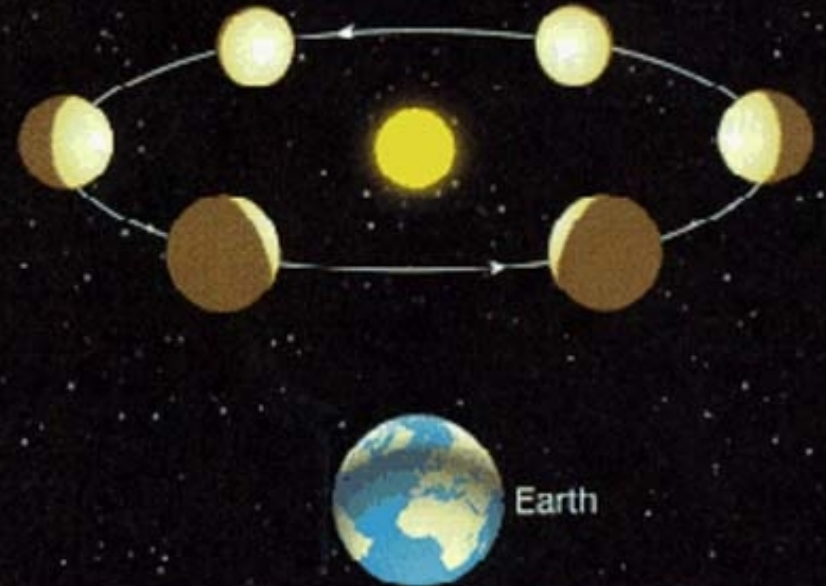
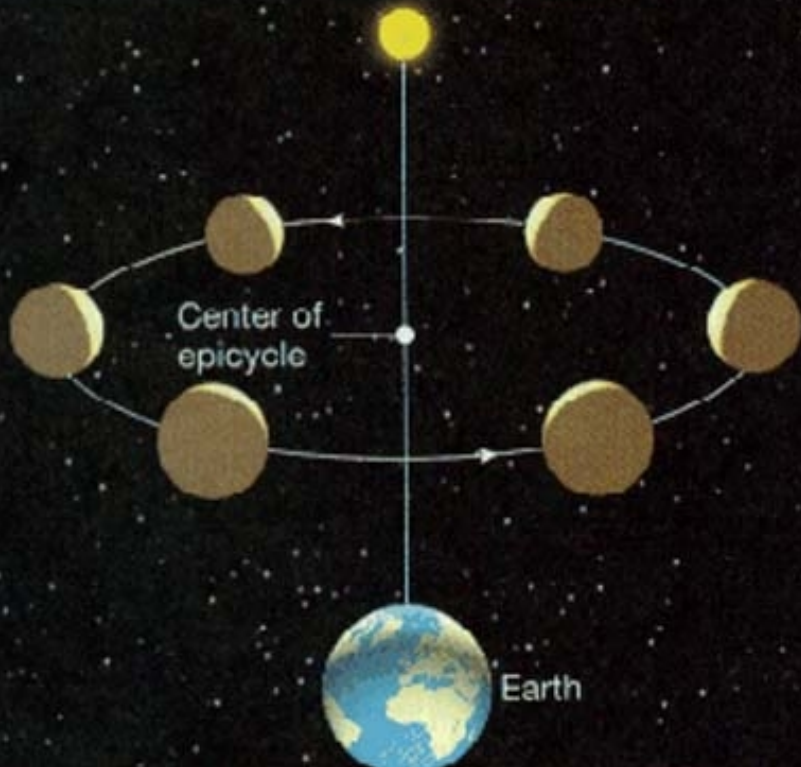
- Scientific “Martyr” at hands of Church
- Jupiter probe named Galileo
- Should have been a TMNT
- Immortalized by Star Trek episode “Galileo 7”
- But I digress...

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- Galileo: The First Modern Scientist
 - Application of the telescope to the sky
 - Craters/mountains on moon – not “perfect”
 - The Milky Way is not smooth, but OMG, full of stars
 - Planets not points like stars
 - Jupiter has moons – center of its own system
 - Named the “Galilean Moons”
 - Really KEY: *Phases of Venus* test of Ptolemaic vs. Copernican systems (as usual see wiki)

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- Phases of Venus!!! Model testing...



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- Phases of Venus!!! Model testing...



Statis Kalyvas

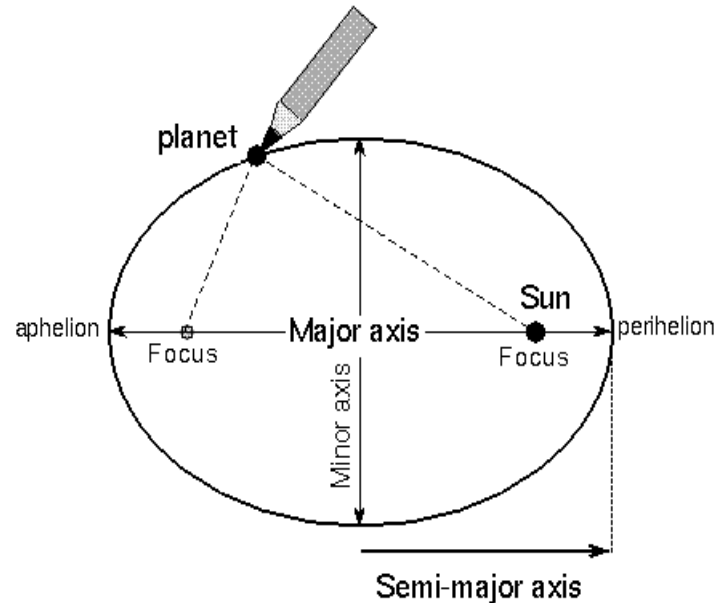
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- Kepler's Laws of Planetary Motion

- What? Where's Tycho in the text? One frakking paragraph? The best stories are about him. His supernova (how do I get one?). His nose. How he died. Something about a horse...
- Kepler got to play with all the data, the fun part...since Tycho did all of his observing before the telescope (even though we just talked about Galileo and his telescope before this, so note the text isn't exactly in historical order strictly speaking...)
- Also a bit light on Kepler's mysticism, perfect Greek solids, etc.
- But I digress...

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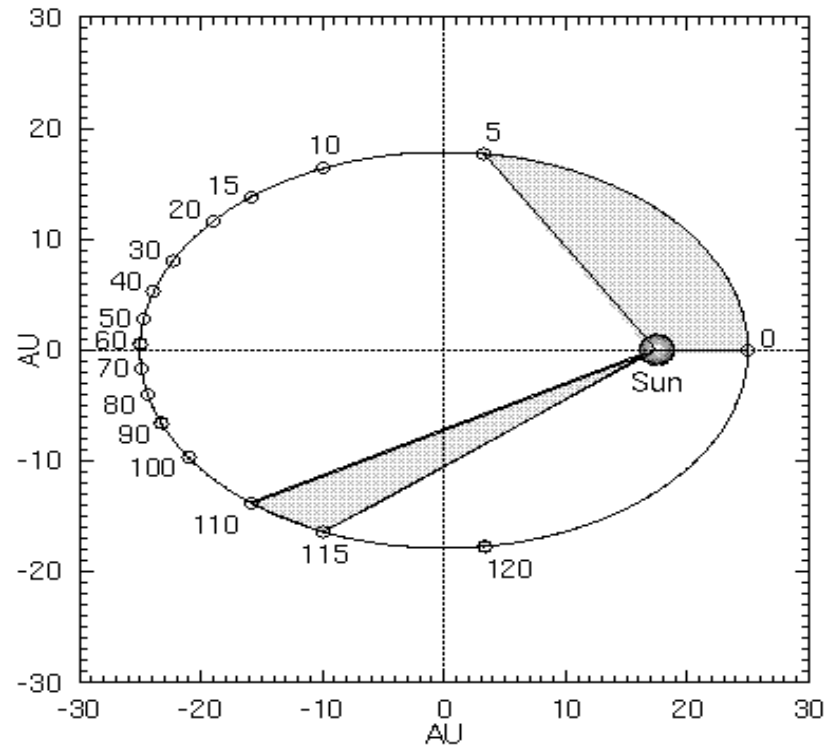
- Kepler's First Law of Planetary Motion
 - Planets travel along **ellipses** with the sun at one focus.



Drawing an **ellipse**: loop string around thumb tacks at each **focus** and stretch string tight with a pencil while moving the pencil around the tacks. The Sun is at one focus.

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- Kepler's Second Law of Planetary Motion
 - “Equal Area in Equal Time”



An elliptical orbit with the Sun at one focus (not the center)

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- Kepler's Third Law of Planetary Motion

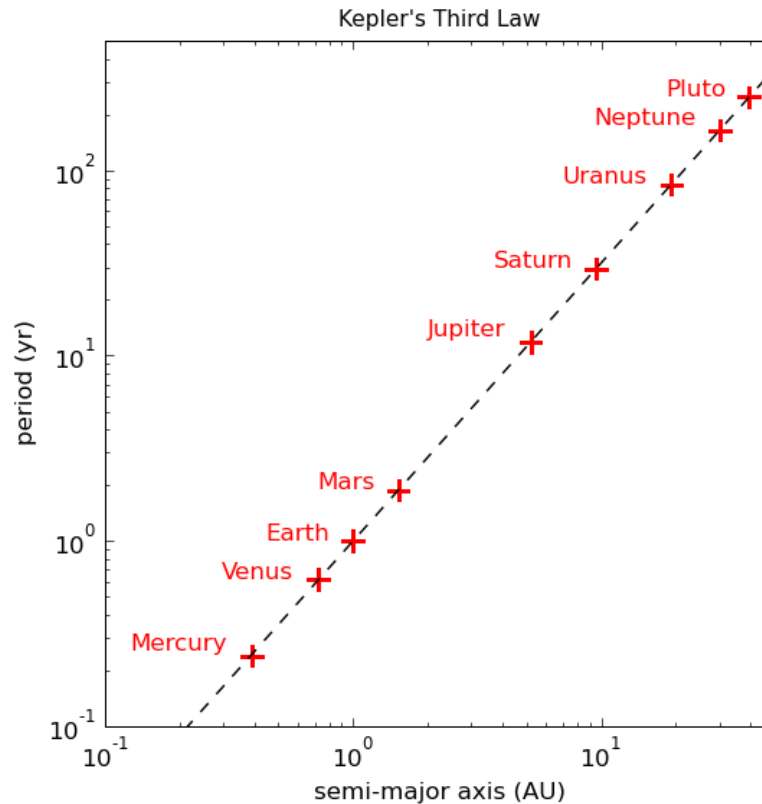
$$\bullet P^2 = Ka^3$$

where K is a constant, or $1 \text{ yr}^2 \text{ AU}^{-3}$ for the solar system

and P is the period, a is the semi-major axis of orbit

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- Kepler's Third Law of Planetary Motion



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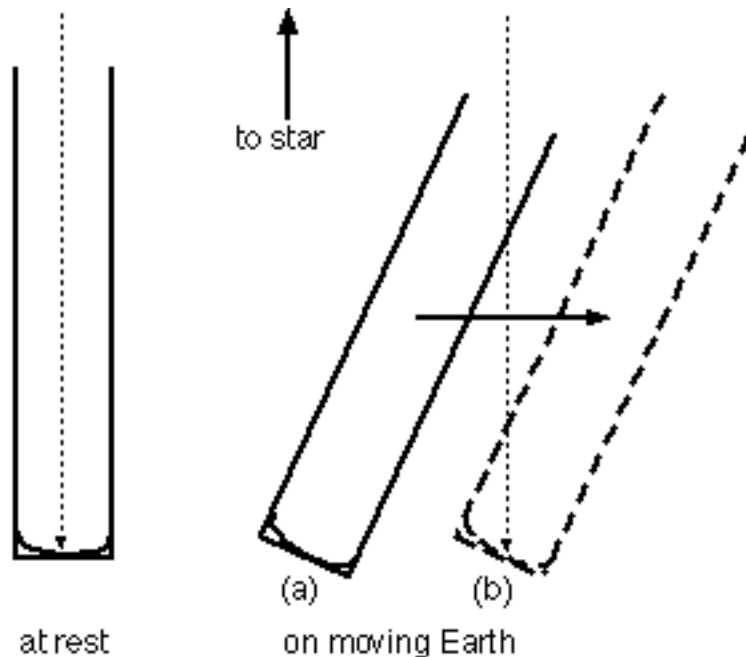
- Proofs of Earth's motion
 - Coriolis Effect
 - Hurricanes
 - Toilets (Not!)
 - Foucault's Pendulum
 - Going to skip the quantitative part, I think...
 - If you're ok with cross products and such, read
 - Will get it in upper-level mechanics

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- Proofs of Earth's motion
 - Aberration of Starlight
 - Running through the rain with an umbrella
 - Speed of light is high (300,000 km/s), but...
 - Speed of Earth around Sun is 30 km/s
 - Detectable (by Jean “Luc” Picard in 1680)

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- Proofs of Earth's motion
 - Aberration of Starlight



$$\tan \theta = \theta = v/c$$

Or for 30 km/s and c

20.5 arcseconds, very detectable centuries ago and now, also. Another effect to go into telescope pointing models.

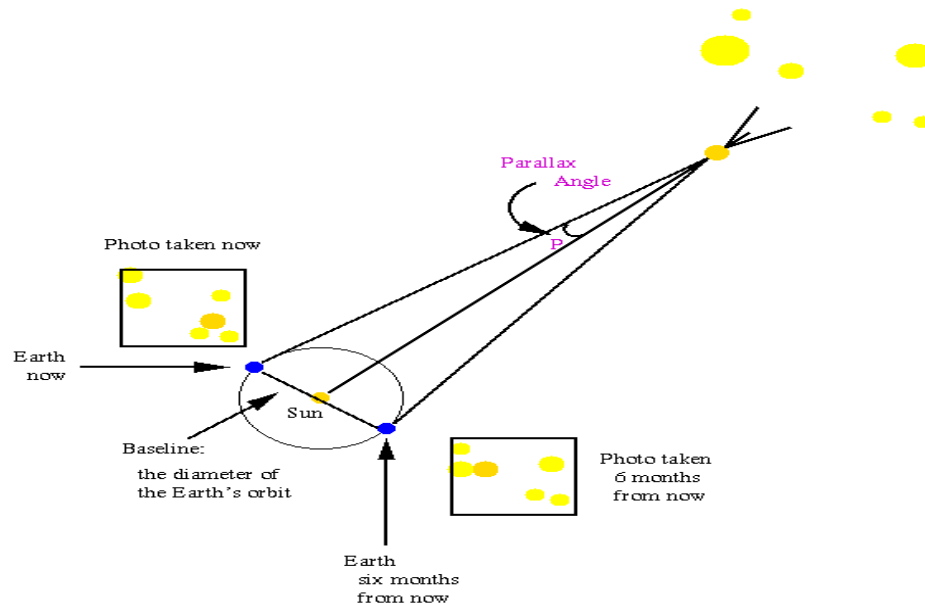
Aberration of starlight: If the telescope is moving then the telescope must be tipped so that light entering the telescope at position (a) will reach the bottom of the telescope when the bottom gets to position (b).

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- Proofs of Earth's motion
 - Stellar Parallax
 - Gold Standard really...predicted for thousands of years, just small because stars so far away...
 - How far away?
 - Simple small angle trig...

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- Proofs of Earth's motion
 - Stellar Parallax: $d=1/p$ or $1/p_i$ in units of arcseconds and parsecs (=3.26 light-years which is 206,265 AUs)



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- Conclusion about stellar distances:

Space is big. You just won't believe how vastly, hugely, mind- bogglingly big it is. I mean, you may think it's a long way down the road to the chemist's, but that's just peanuts to space.

Douglas Adams, *The Hitchhiker's Guide to the Galaxy*. English humorist & science fiction novelist (1952 - 2001)