

Astronomy 230



off the mark by Mark Parisi
www.offthemark.com



This class (Lecture 23):
Evolution of World View
Ken Sampson

Next Class:
Evolution of World View

Music: <http://youtube.com/watch?v=eFAxumuzmN0>

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HW 3



- **Octavio Mendoza:**
<http://www.ufosoveramerica.com/>

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Presentations



- **Ken Sampson:** Alien Abductions

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Outline



- From intelligence to communication
- Will a civilization develop that has the appropriate technology and worldview?
- Requires knowledge of quantum mechanics and astronomy.

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Drake Equation

That's 0.26 intelligent systems/decade

Frank Drake



$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

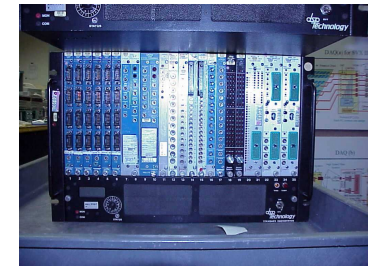
# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that communicate	Lifetime of advanced civilizations
	15 stars/yr	0.5 systems/star	2.7 x 0.134 = 0.36 planets/system	0.095 life/planet	0.1 intel./life	comm./intel.	yrs/comm.

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Cultural Evolution



- What do we mean by cultural evolution?
- Is that like evolution's natural selection?
- Since technology has developed out of it, we can conclude that technology was a desirable trait that is likely to develop on any planet with competition between cultures.



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Cultural Evolution



- Or can we?
- If so, then would have to say that cultural evolution follows a punctuated equilibrium model.
- Or, episodic progress with long periods of dark ages.
- Like species, the fate of civilizations has been extinction, but their technology was adopted by others (cultural diffusion).

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Evolution?



- The main point is how likely is it that technological civilizations exist on other planets?
- Hard to determine on Earth, but there are some points:
 - Agriculture arose independently in Mexico and probably China, Andes (potatoes), and eastern US (sunflowers).
 - Written language independently in Sumer, China, and the Americas, maybe India and Egypt.
 - But, the wheel was not invented outside of Sumer.
 - For recent developments, the world was in too much contact to distinguish.

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Questions: Variations of Civilization



- What if the Americas had invented gunpowder?
- What if the Americas had large animals of burden?
- What if the germs of Europe were less dangerous than the germs of the Americas?
- Similar examples of cultural devastation in the Pacific Islands.
- Often cultures are wiped out from *Guns, Germs, and Steel* (by Jared Diamond)—manifestations of geography.

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Technology Development



- Our sample of one, makes it difficult to determine if technological development (to communication ability) is a fundamental step from intelligence.
- Does it depend on the planet— water/desert dominated?
- How would metal poor planets develop?
- Does the competition of civilizations matter?
- Is there a dependence on psychology of the intelligence life?

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Technology



- Cultural evolution was fast.
- Especially after agriculture freed civilizations.
- Development of language.
- Increase of extra-somatic storage.
- We're living in a silicon age.
- Does the development of technology also include a correct worldview?

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Next Step



- Besides needing technology, intelligent life must have a **want** to communicate with extraterrestrial life.
- That means that it MUST believe in the possibility of other life.
- Requires civilization to undergo three steps:
 1. A correct appreciation of the size and nature of the Universe
 2. A realization of their place in the Universe
 3. A belief that the odds for life are reasonable. The beings of Qearth must have taken their Qastro 230 class and came up with a good number of communicable civilizations in the Q'drake equation.



<http://www.bybeeweb.com/cats/amelia-step.jpg>

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Our First View



- The first concepts of the Universe were Earth-centered.
- How did we come to this point– Astro 230?
- First recorded cosmology was from the Babylonians.
 - The Universe is a large oyster, and we are inside.
 - But other aspects of their astronomy was advanced.
 - Regularity of astronomy for crop planting, harvesting, and accurate calendars back to the 3800 BC.



<http://www.internationalenglish.co.uk/courses.htm>

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Our First View



- The Mayans computed the length of year to within a few seconds (0.001%).
- So early humans had a weird mixture of precise calendar astronomy with primitive concept of the Universe and mythological systems incorporating magic.



<http://www.mayasites.com/equinox.html>



<http://ephemeris.com/history/mayan-calendar.jpg>

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Greek Astronomy



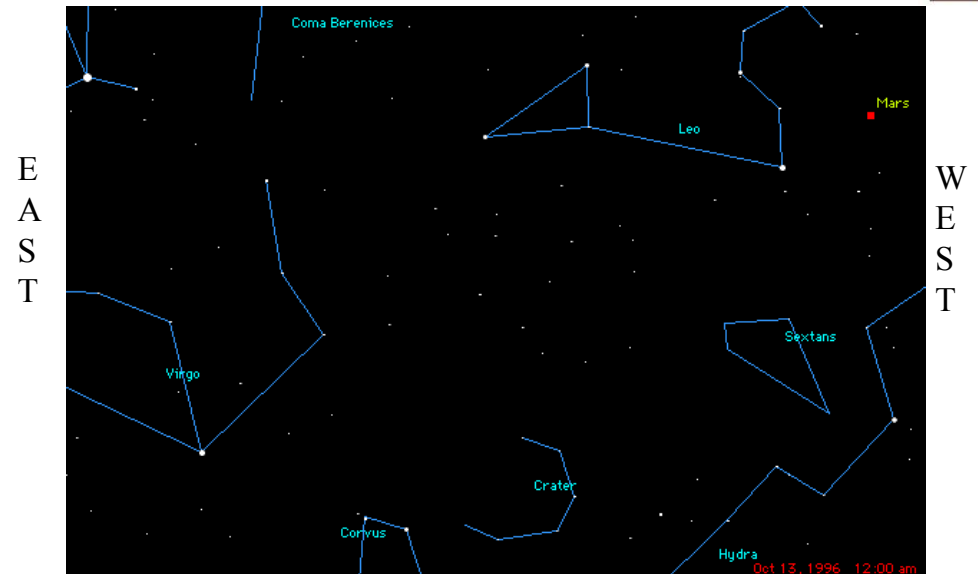
- Greeks were excellent Astronomers
 - Cataloged star positions & brightness.
 - Systematic, quantitative observations.
 - Natural philosophers.
- They observed that the stars, Sun, and planets revolved around the Earth.
- So Earth is center of Universe- **geocentric cosmology** (mostly from Plato and Aristotle).
- Even though other philosophers (Aristarchus) argued for a heliocentric cosmology.
- Perfect Spheres of motion?



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Mars Moves WRT the Stars!



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Motions of Planets



- So, over time the planets seem to move along the ecliptic from west to east over long time periods.
 - This is called **prograde** motion
- But once in a while, a planet appears to stop and reverses direction
 - Reverse direction is called **retrograde** motion (east to west).
- Planets move counter-clockwise (looking down at the north pole)

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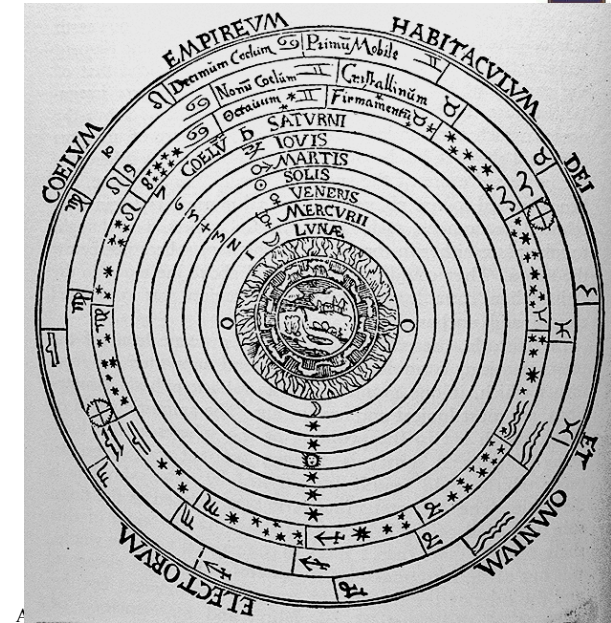
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How can we explain the Planet motion?



But for a **geocentric cosmology** you can't easily explain the retrograde motion of the planets.

Note: perfect circles



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Ptolemy (140 AD: 'p' is silent)



Took **geocentric** model with uniform circular motion to introduce the Ptolemaic system, or model, of the Solar System that explained **retrograde** motion



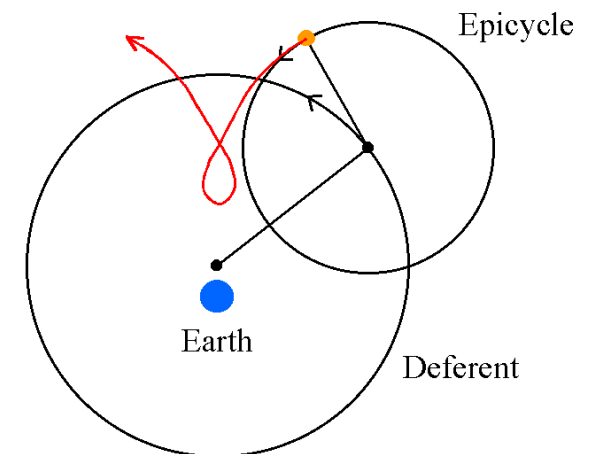
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Ptolemaic system



- Geocentric
- Nice circular motion



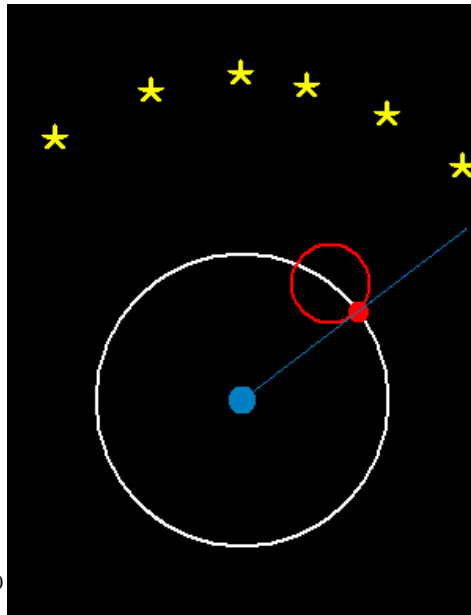
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Ptolemaic system



**Yes, it can
explain
retrograde
motions**



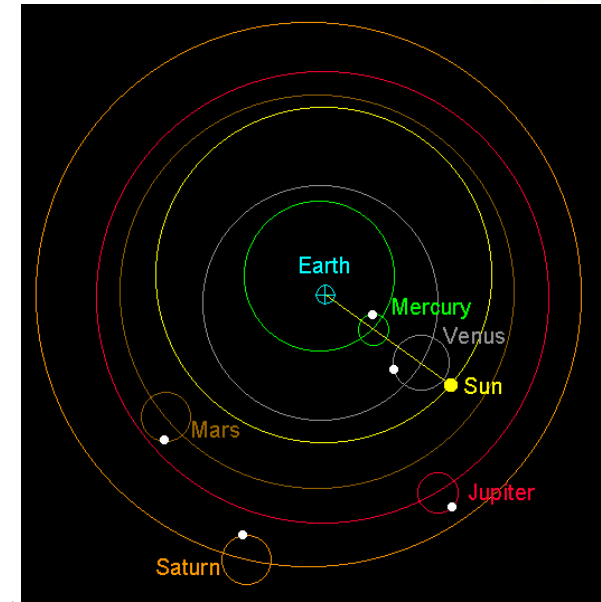
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Ptolemaic system



Overall system of
the Solar System.



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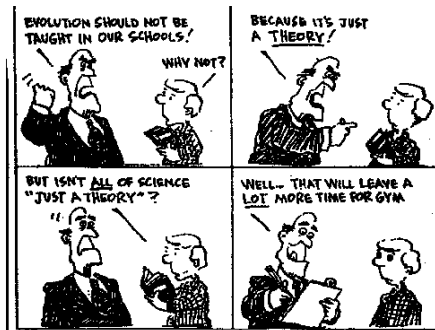
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Ptolemy's Geocentric Cosmology: Is it a Scientific Theory?



Yes! ...and an accurate one too

- Data: Sun/moon/star motions
- Tentative Model: circular orbits
- Prediction: uniform motion on sky
- New data: retrograde motion
- Refined model: epicycles
– explains data!



<http://home.comcast.net/~fsteiger/theory.htm>

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Ptolemy's Geocentric Cosmology: Is it a Scientific Theory?

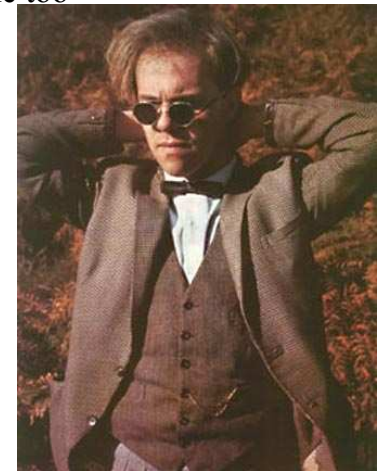


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– explains data!

Result: Ptolemaic system (theory)

- *Strength:* accurate fit of data
- *Weakness:* predictions for new data?



<http://www.tmdrfan.com/rthurlow/ThomasDolby1982.htm>

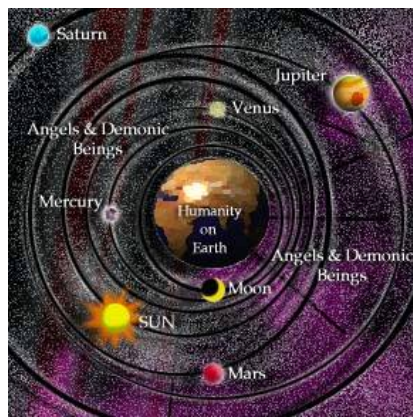
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Ptolemaic Problems



- Each planet acted independently of others
- There was no universal rule governing the planets motions.
- Nonetheless, for a 1000 years this model ruled western thought
- However, by the late middle-ages astronomers felt that it was too complex, and a search began for a system with simple underlying principles



<http://gbgm-umc.org/umw/bible/images/ptolmai2.jpg>

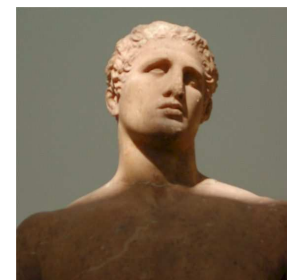
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Lessons: Were the Greeks Stupid?



- Not at all!
Developed sophisticated, successful model
- But built in prejudices about the world
not just geocentric but egocentric



- What about scientists today?
Still can fool ourselves! (And have!)
But: *scientific method* is tool:
- To keep from fooling yourself
 - To correct yourself when you have

My guess:

- 70%** of the material in this course will stand the test of time
- Compare baseball: 30% success good
 - But also: 30% of course is wrong/incomplete!
 - Which 30%? Don't know! Would fix it if we knew! So...
 - You have to learn all of it!

http://www.farhorizon.com/europe/images/images-greece/head_of_Greek_god.jpg

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Power of Ignorance



- Geocentric model was absorbed by Christianity.
- If Geocentric, then of course no ET life.
- St. Augustine (420 AD) incorporated Neo-Platonism. He listed science as a temptation to avoid: "a mere itch to experience and find out"
- Also said, "Nor do I care to know the course of the stars."



http://www.flholocaustmuseum.org/history_wing/assets/room1/St_Augustine.jpg

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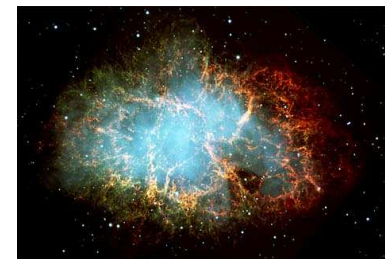
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Power of Ignorance



- The European worldview degenerated for years.
- No one in Europe mentioned the supernova of 1054 (Crab Nebula), unlike China or Americas. People were afraid to notice it and be described as a heretic.
- Could an ET civilization reach technology with that sort of attitude?

<http://www.pbs.org/deepspace/timeline/tl14.html>

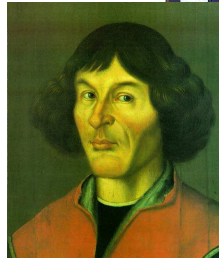
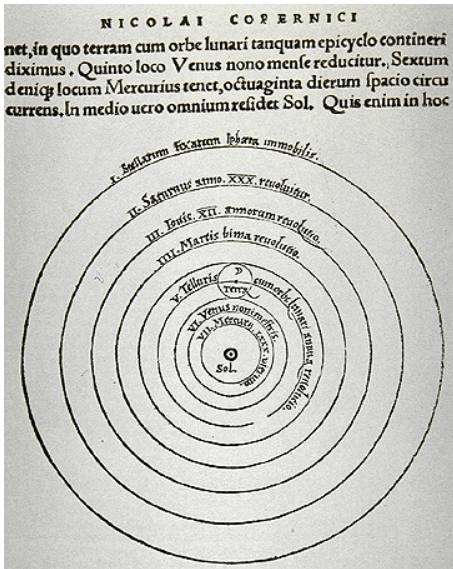


<http://www.godandscience.org/images/crabnebula.jpg>

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<http://www.tulane.edu/~danny/southwest.html>

Copernicus (1540) resurrected the heliocentric model



- If Earth moves, then stars have to be very far away.
- Was rejected on theological and philosophical grounds.
- 1616, the Church listed it as heresy.

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Giordano Bruno

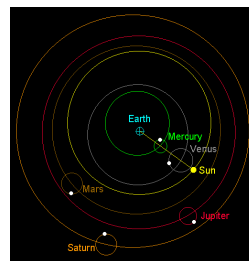
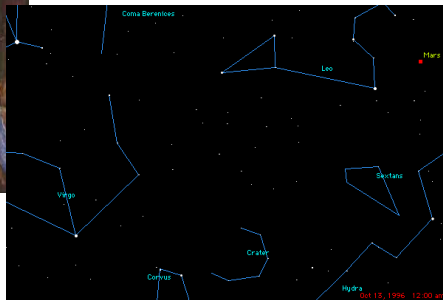


- Seems to have taken it one step further.
- Thought that the stars were all little Suns.
- Possibly with planets of their own.
- Maybe life on those other planets.
- Maybe more advanced than those on Earth.
- These are some of the reasons why he was burned at the stake around 1600.

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Our View Evolution



<http://www.internationalenglish.co.uk/courses.htm>

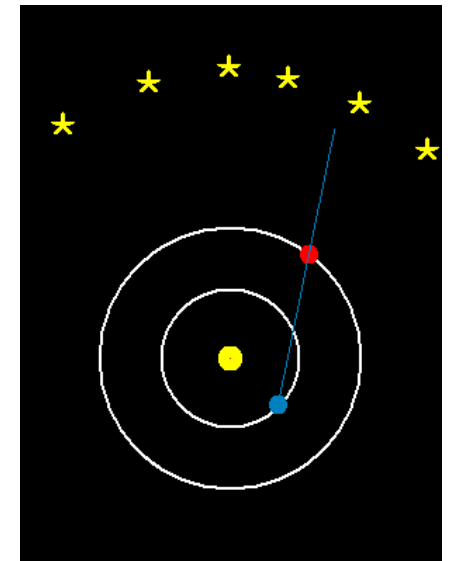
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Copernican Theory



- Can explain retrograde motion
- Much simpler
- Still kept to circular motion
- Eventually changed the way we think of ourselves!



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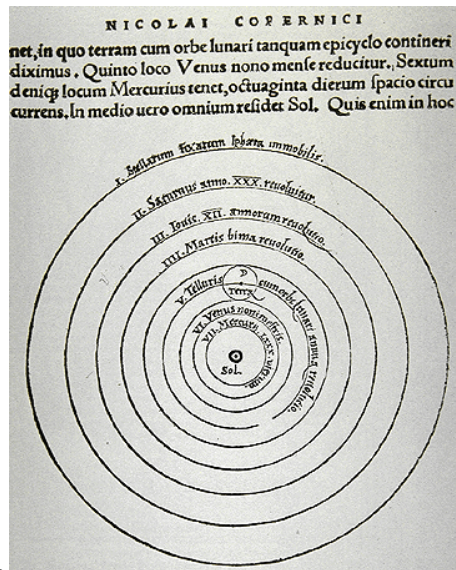
Copernicus (1540) Heliocentric Model



BUT, keep in mind that the geocentric model was still valid. Both models explained the observed motion.

Heliocentric is NOT obvious!

IT was determined a philosophical argument for 50 years! New observations were required to determine which is correct.



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Tycho Brahe (1580): Uraniborg



Accurate measurements to about 1 minute of arc (1/15 the diameter of the moon). No telescopes!



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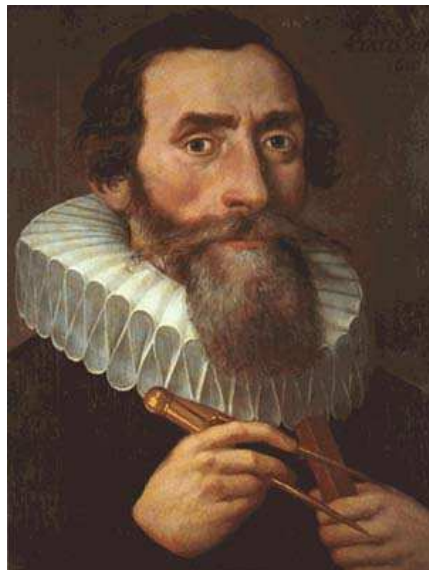


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Johannes Kepler (1600)



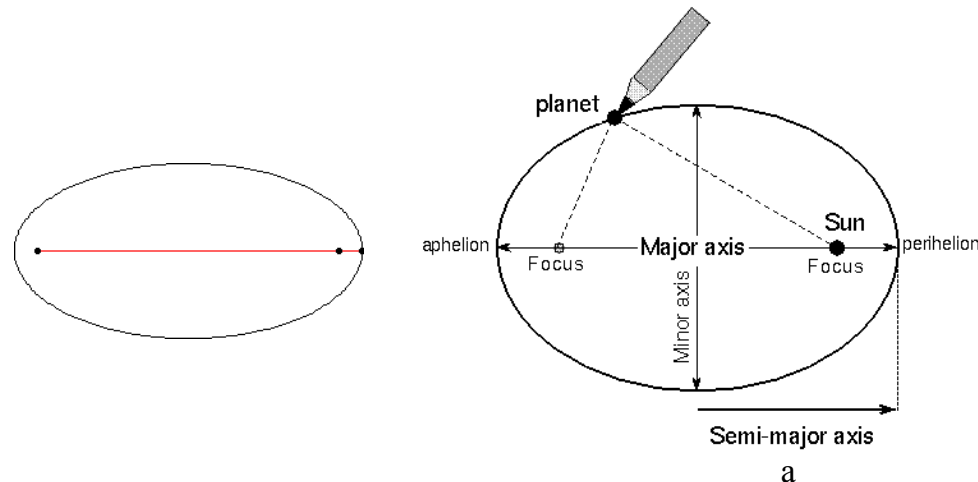
- Tycho's assistant in Prague
- After Tycho's death, succeeded Tycho's position and had access to the excellent data
- How to fit the Heliocentric model to accurate data of Mars?
- Circles didn't work.
- Ellipses!



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Kepler's 1st Law: Orbits of planets are ellipses with the Sun at one focus



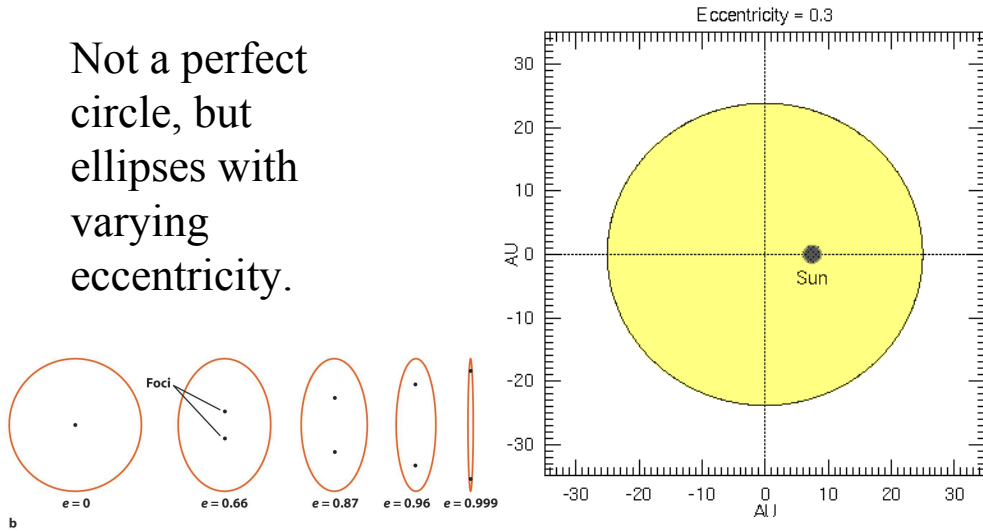
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Orbits of planets are ellipses with the Sun at one focus



Not a perfect circle, but ellipses with varying eccentricity.



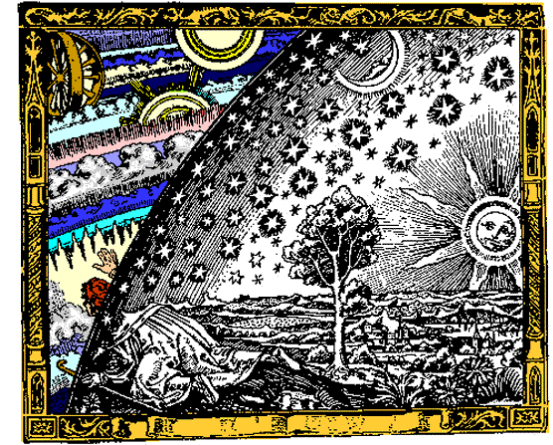
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Implications



New Twist– even the Sun isn't at the center of the solar system now. How does that change our view of the Universe and our place in it?

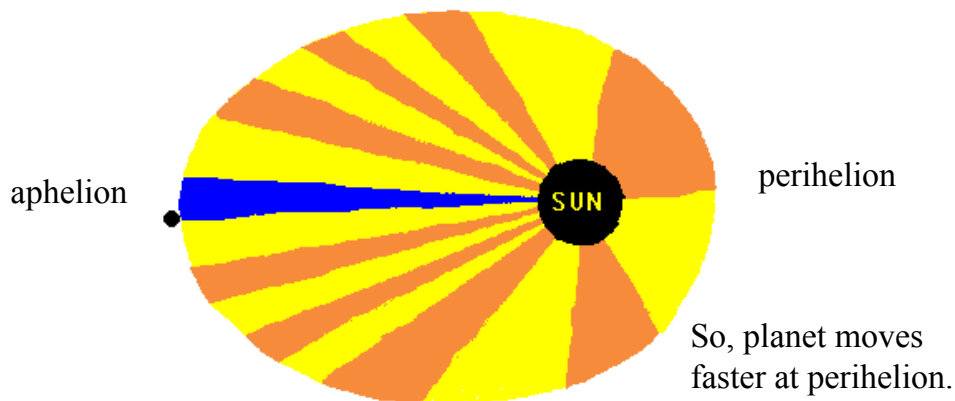


<http://antwrp.gsfc.nasa.gov/apod/ap010101.html>

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Kepler's 2nd law: The Line that connects the planet to the Sun sweeps out equal areas in equal time



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Kepler's 3rd Law: The squares of the orbital sidereal periods of the planets about the Sun are proportional to the cubes of the orbital semimajor axes



Planet	P (yr)	a (AU)	P ²	a ³
Mercury	0.24	0.39	0.06	0.06
Venus	0.61	0.72	0.37	0.37
Earth	1.00	1.00	1.00	1.00
Mars	1.88	1.52	3.5	3.5
Jupiter	11.86	5.20	141	141
Saturn	29.46	9.54	868	868

$$P^2 = a^3$$

$$P \times P = a \times a \times a$$

Where P is in years and
a is in AU.

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Kepler's Laws



The farther away from the Sun, the longer it takes for the planet to orbit AND the slower it's average orbit speed.

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Galileo (1610)



First to systematically use the telescope (but did not invent it).

- Moon has mountains and valleys
- Milky Way consists of faint stars
- Saturn is elongated
- Venus shows phases
- Jupiter has moons (now called Galilean moons)

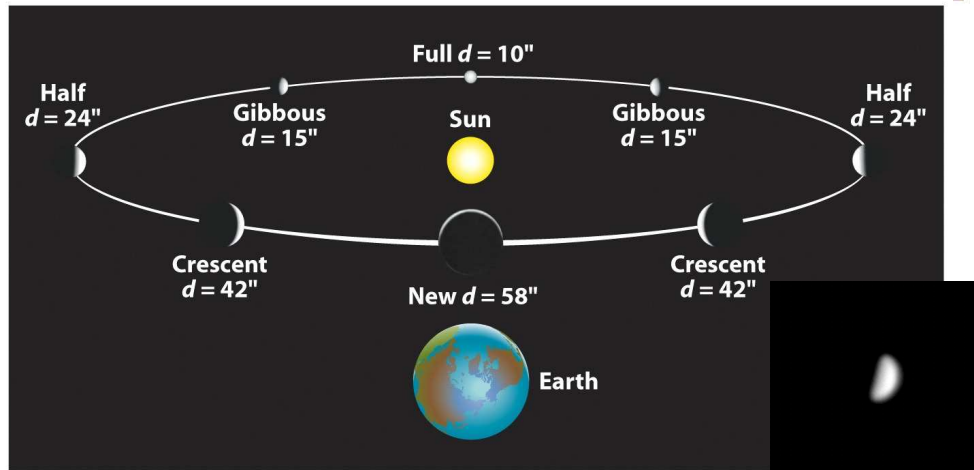
Wow! Big stuff. The moons of Jupiter did not orbit the Earth!



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The Phases of Venus



Could not be explained with the Geocentric model

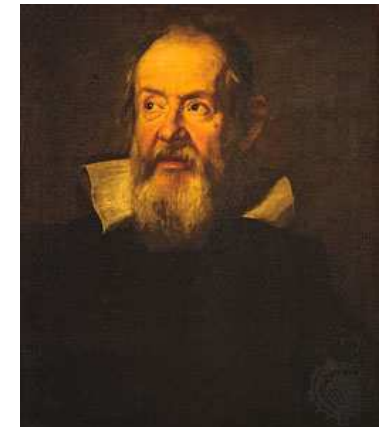
<http://www.astro.ubc.ca/~scharein/a310/SolSysEx/phases/Phases.html>

<http://www.calvin.edu/academic/phys/observatory/images/venus/venusb.html>

Galileo (1610)



- Disproved Ptolemaic system
- Rome bullied him into recanting (cleared in 1992)
- Now we understand the motions and the fact that the solar system MUST be Heliocentric, but now we need a reason why?
- Need something with predictive power.



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Isaac Newton



- Gave us a reason why-- GRAVITY.
- Developed fundamental laws of nature.
- Kepler's 3rd law now became a way to probe the structure of the Universe!
- We are not the center of the Universe.
- In the 1920s, we realized that we are not the center of the galaxy, and that there are many other galaxies.

