

Astronomy 330



This class (Lecture 21):
Evolution of World View
Gretchen Bromann
Racquel Ardisana

Next Class:
Lifetime
Mark Mazzone
Andrew Xie

Music: *Jesus came from Outer Space* – Supergrass

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Paper Rough Draft



- Worth 2% of your grade, but really worth more.
- **Due on or before April 10th!**
- Should include most of the details of the final paper.
- Will be looking for scope, ease-of-read, scientific reasoning, **proper citation**, and general style.
- 8 to 10 pages double-spaced 12-point font, not including references.
- ***Mars is a planet without an overzealous monkey population (Holt et al. 2000; James & Mann 2006; Walker 2007).***

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HW #6



- Jack: <http://www.newsweek.com/id/96014/output/print>
- Brent: <http://www.cropcircles.net>
- Nick: http://aliens.monstrous.com/abduction_theories.htm

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Presentations



- **Gretchen Bromann:** [Crop Circles](#)
- **Racquel Ardisana :** [Non-Carbon Based Life](#)

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Outline



- Worldview: do we think aliens may be out there?
- What is f_c ?

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Copernican Revolutions



1. We are not the center of the Solar System.
2. We are not the center of the Galaxy.
3. We are not the center of the Universe.

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Our First View



- The first concepts of the Universe were Earth-centered.
- How did we come to this point– Astro 330?
- 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>

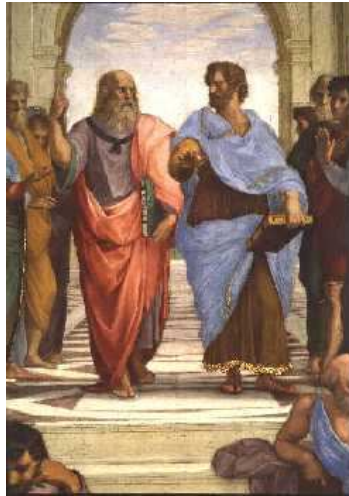
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Greek Astronomy



- 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?



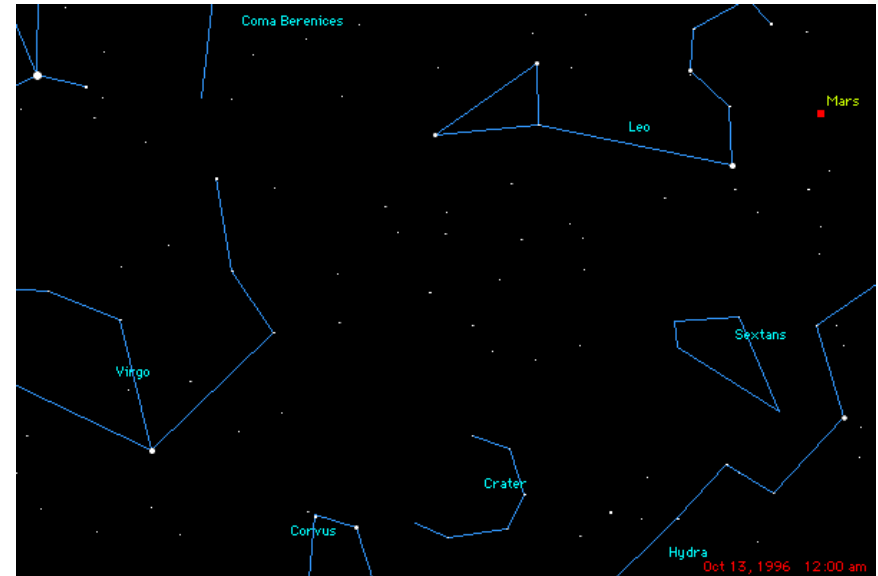
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Mars Moves WRT the Stars!



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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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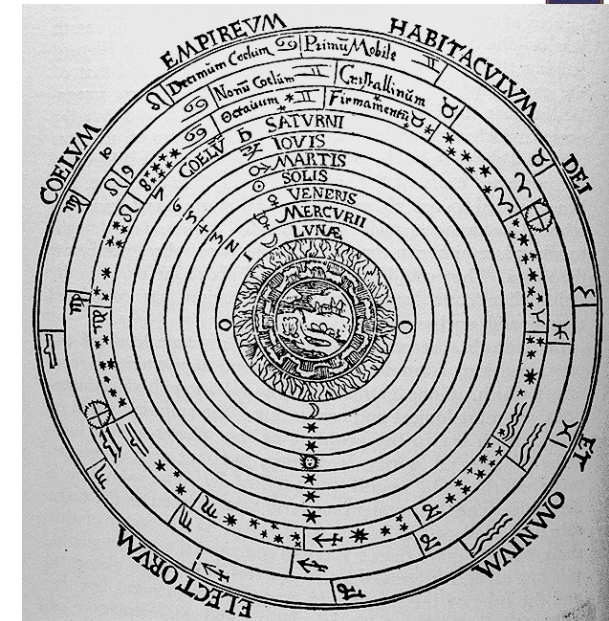
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How can we explain the Planet motion?



But with 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



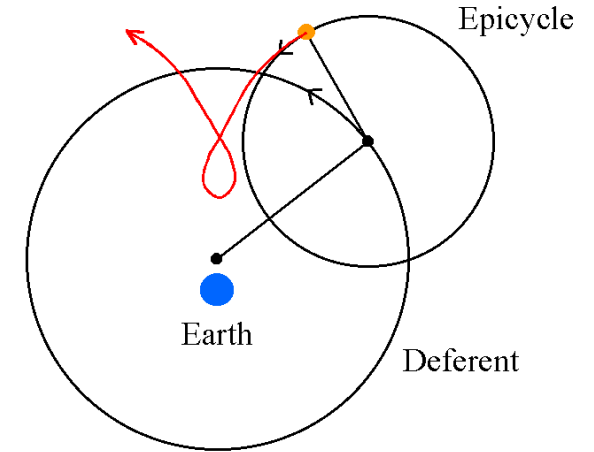
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Ptolemaic system



- Geocentric
- Nice circular motion



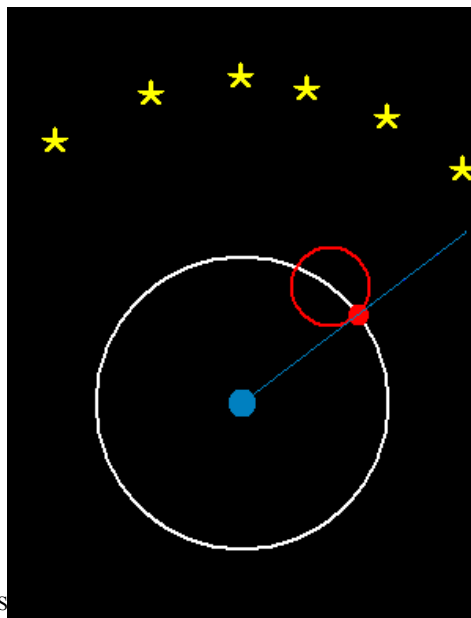
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Ptolemaic system



Yes, it can explain retrograde motions



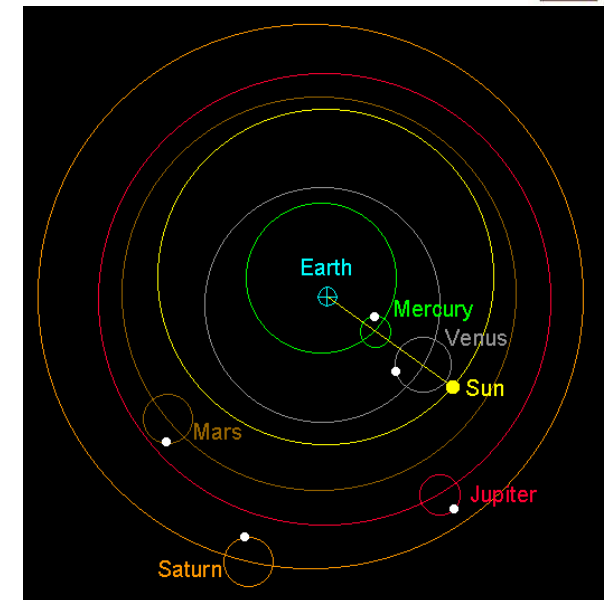
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Ptolemaic system



Overall system of the Solar System.



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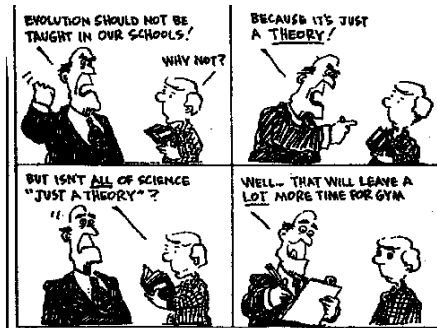
Ptolemy's Geocentric Cosmology:

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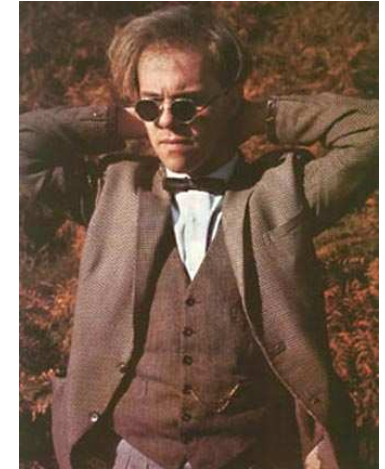
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<http://www.tmdrfan.com/rthurlow/ThomasDolby1982.htm>

Result: Ptolemaic system (theory)

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

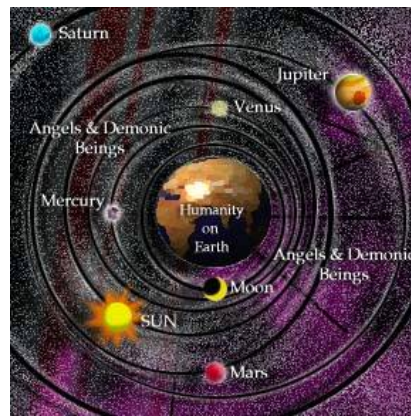
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Ptolemaic Problems



- 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>

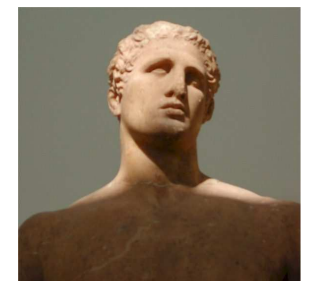
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Lessons: Were the Greeks Stupid?



- 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

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

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Lessons: Were the Greeks Stupid?



My guess:

70% of the material in this course will stand the test of time

- Compare baseball: 70% success is very 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://sportsillustrated.cnn.com/baseball/mlb/specials/spring_training/2007/previews/cubs.html

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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.flholocastmuseum.org/history_wing/assets/room1/St_Augustine.jpg

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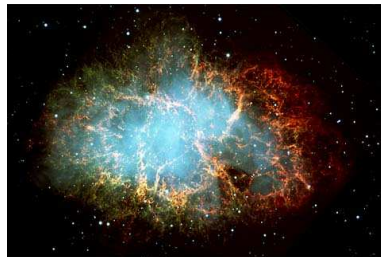
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Power of Ignorance



- 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?

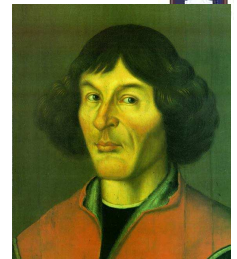
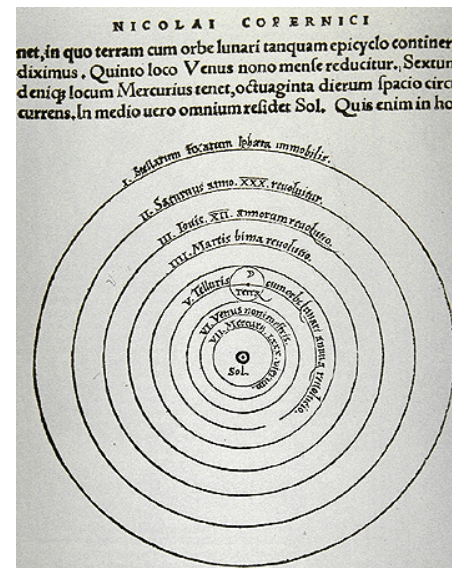
<http://www.pbs.org/deepspace/timeline/t14.html>



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

<http://www.astronomy.com> Astronomy 330 Spring 2008

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.

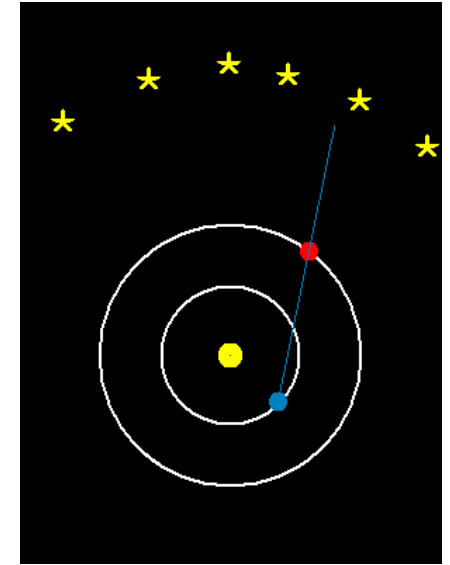
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Copernican Theory



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



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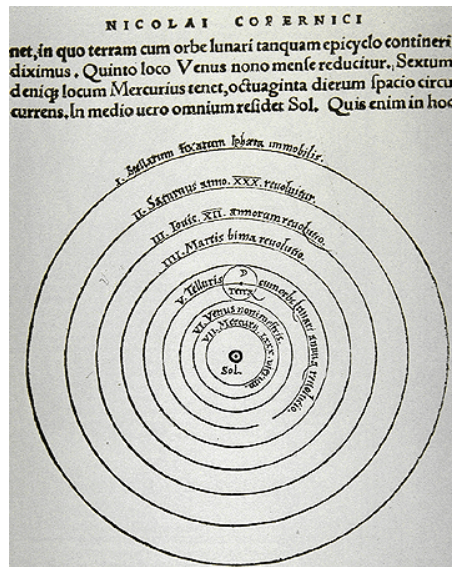
Copernicus (1540) Heliocentric Model



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!



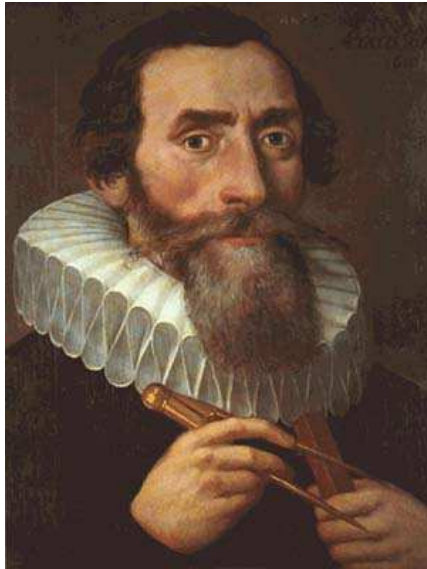
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Johannes Kepler (1600)



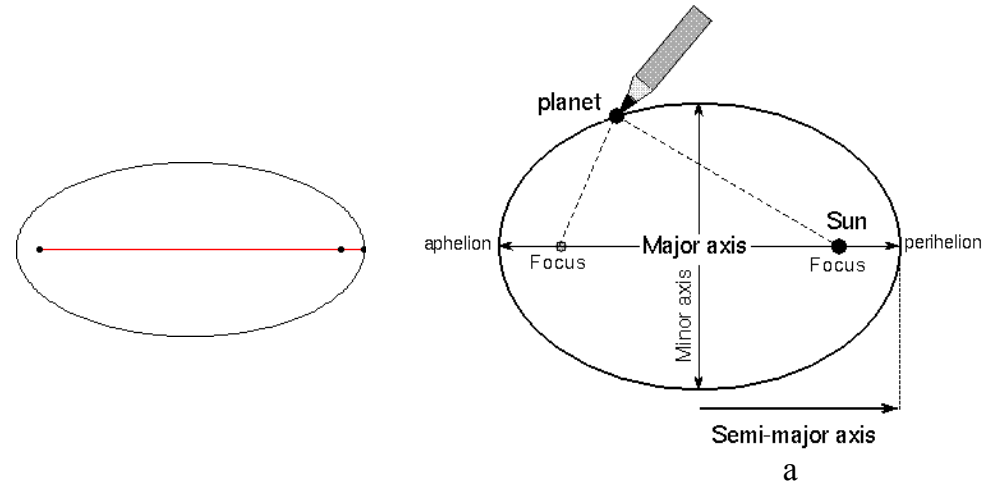
- Tycho's assistant in Prague
- After Tycho's death, succeeded Tycho's position and had access to the excellent data
- How to fit the Heliocentric model to accurate data of Mars?
- Circles didn't work.
- Ellipses!



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



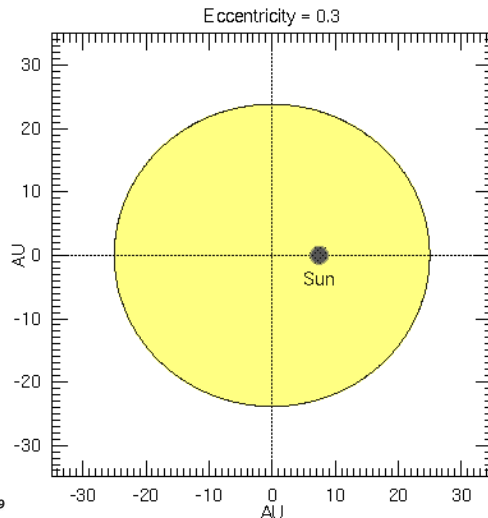
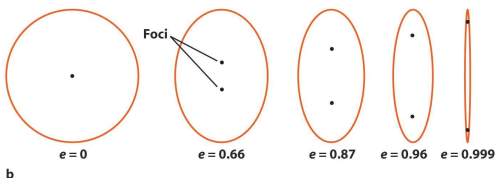
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Orbits of planets are ellipses with the Sun at one focus



Not a perfect circle, but ellipses with varying eccentricity.



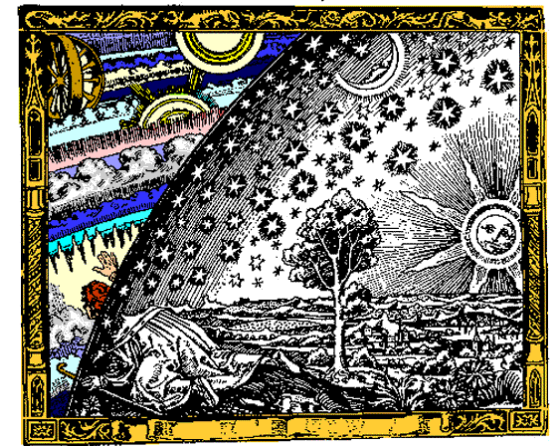
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Implications



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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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)

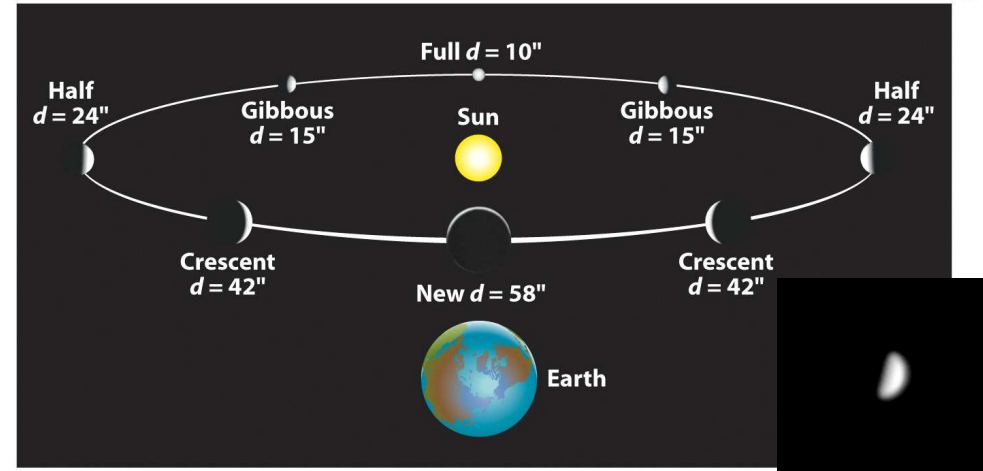
Wow! Big stuff. The moons of Jupiter did not orbit the Earth!



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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/venus.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.



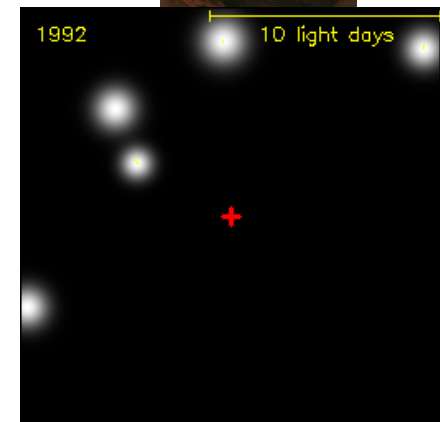
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Isaac Newton



- 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.



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