

Reminder: no food or
drinks in the planetarium!

Astronomy 4 - Solar System Astronomy

Reminders

Instructor: Dr. Ann Marie Cody

codyannmarie@fhda.edu

-Feel free to email me about course questions or astronomy in general.

Class website:

-*<https://amcody.github.io/astro4>*

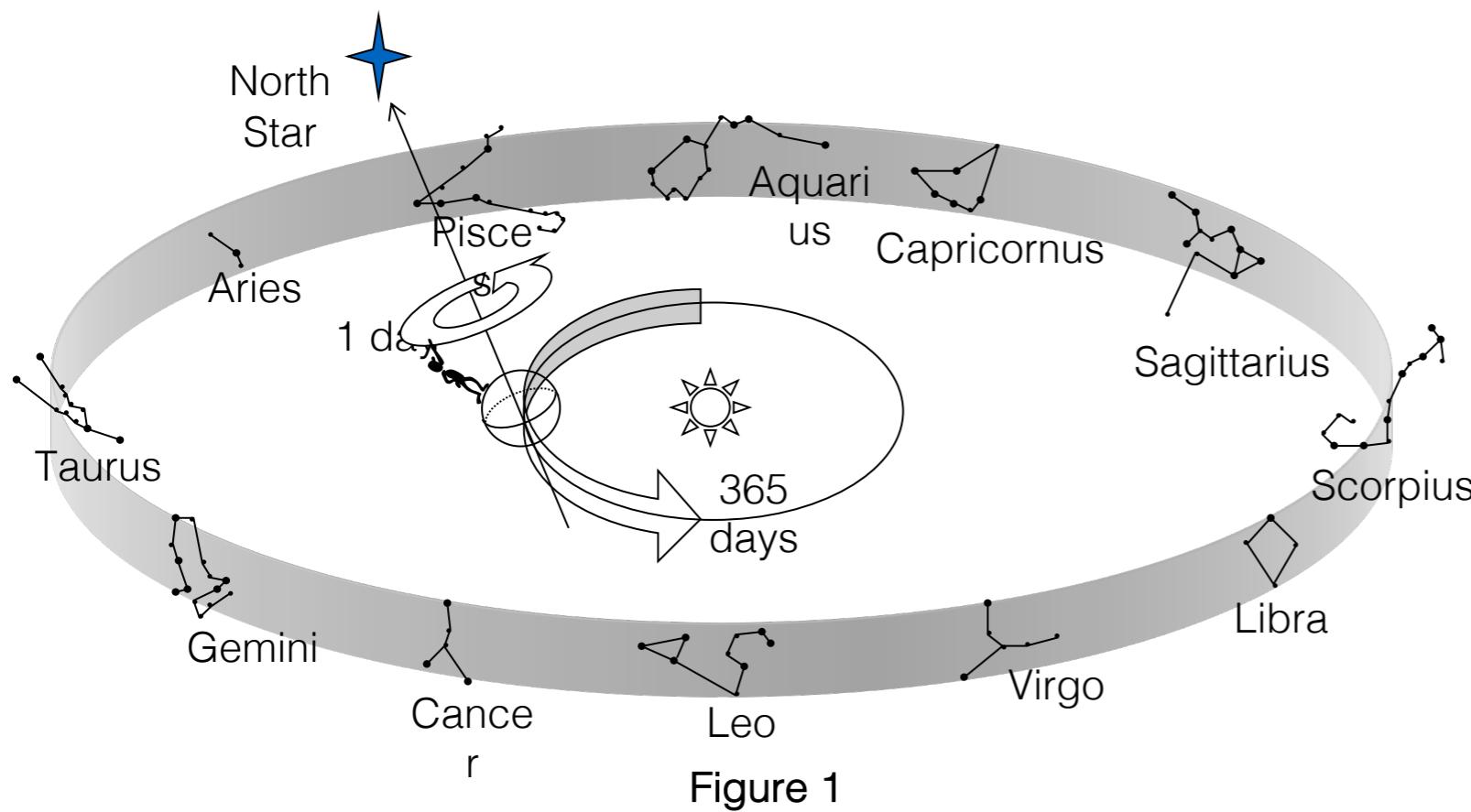
Your one-stop shop for anything course related, including homework readings and exam practice material.

Lost and found:

-At the end of class, check to make sure you aren't leaving anything behind. Any items will be added to the Lost and Found box in back.

The Zodiacal Constellations that our Sun covers up (blocks) in the course of one year

(only 12 are shown here)



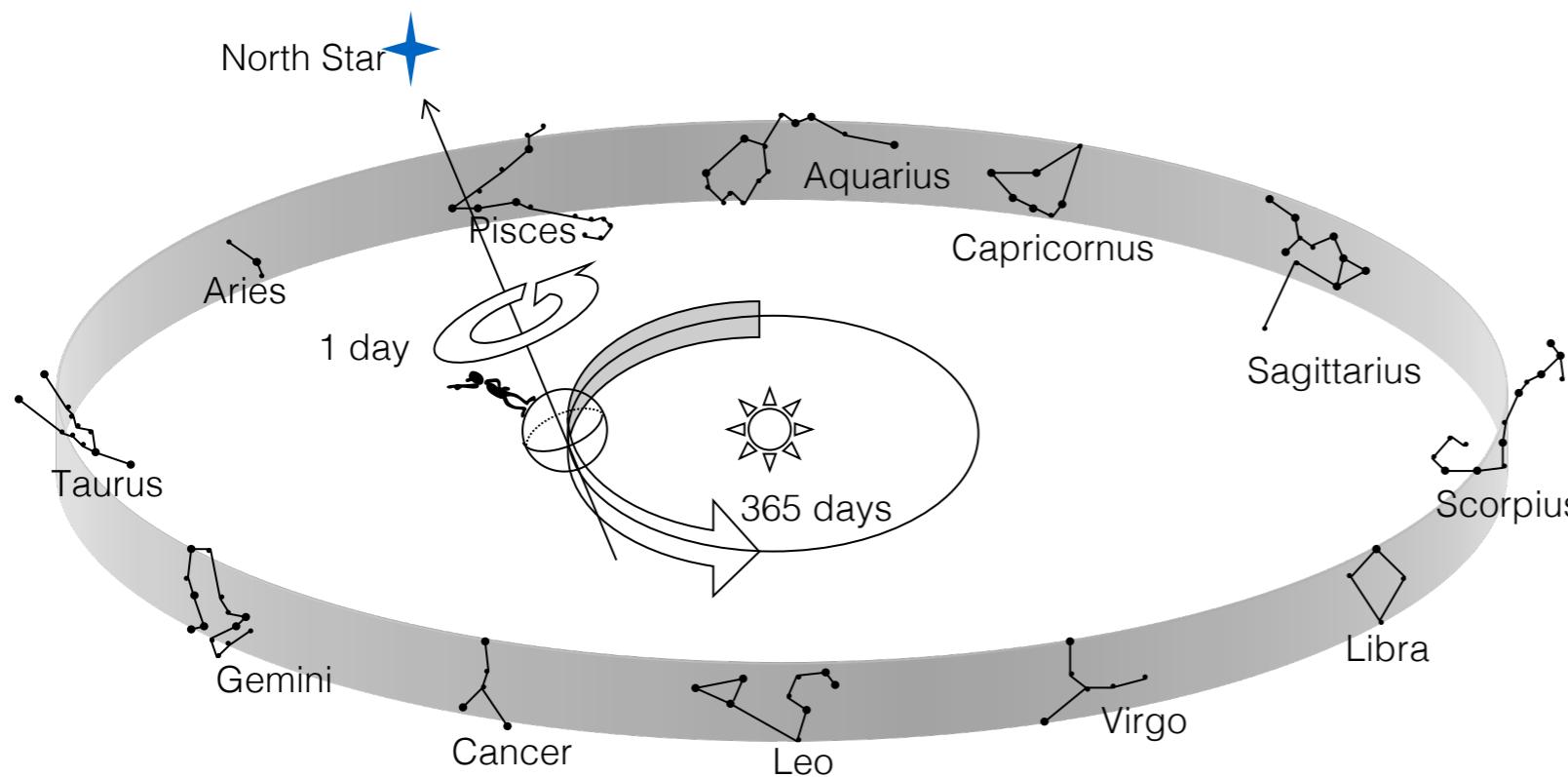


Figure 1

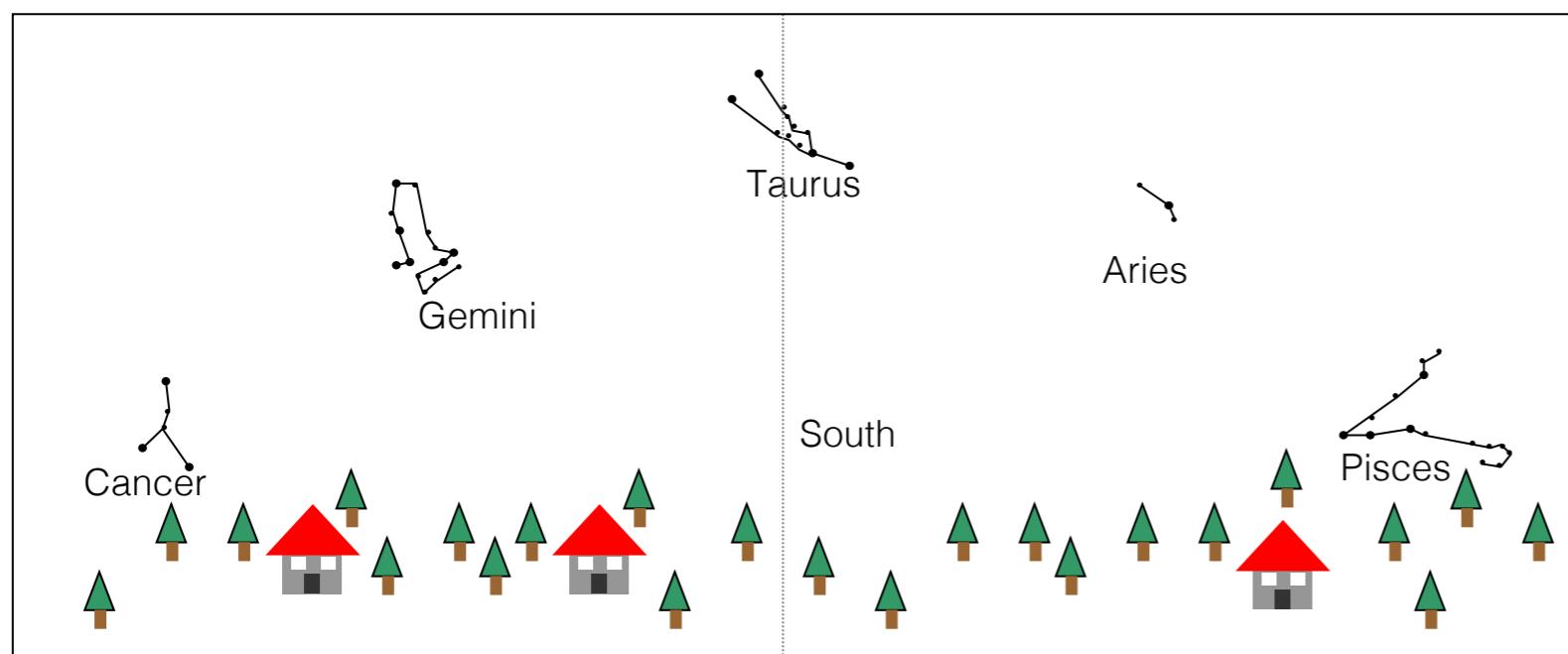


Figure 2 – What it would look like if you were the observer in Figure 1

12 hours later
what object will
be at the position
that Taurus is in
now?

18 hours later
where will the
Sun be?
Where will
Scorpius be?

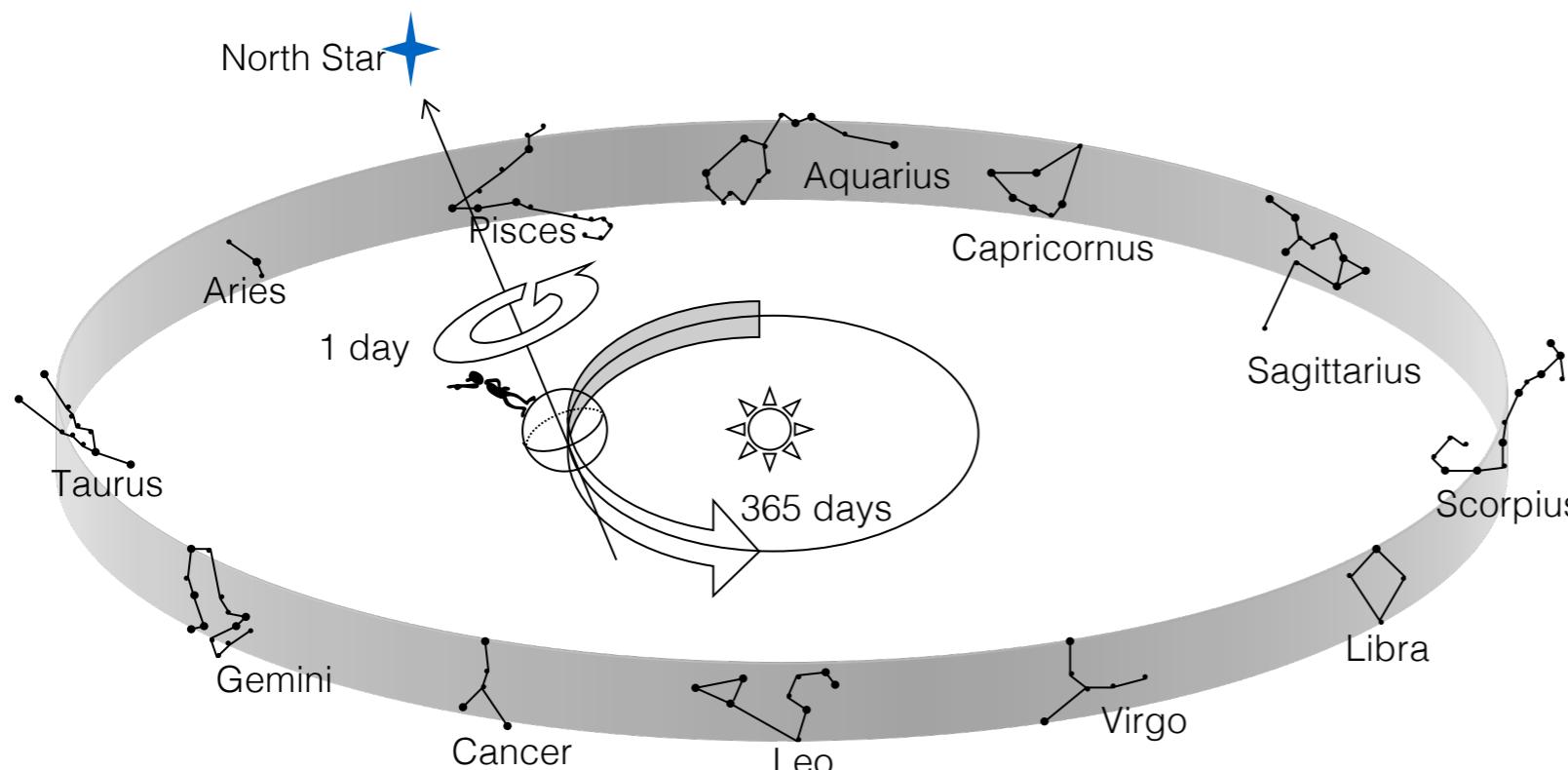


Figure 1

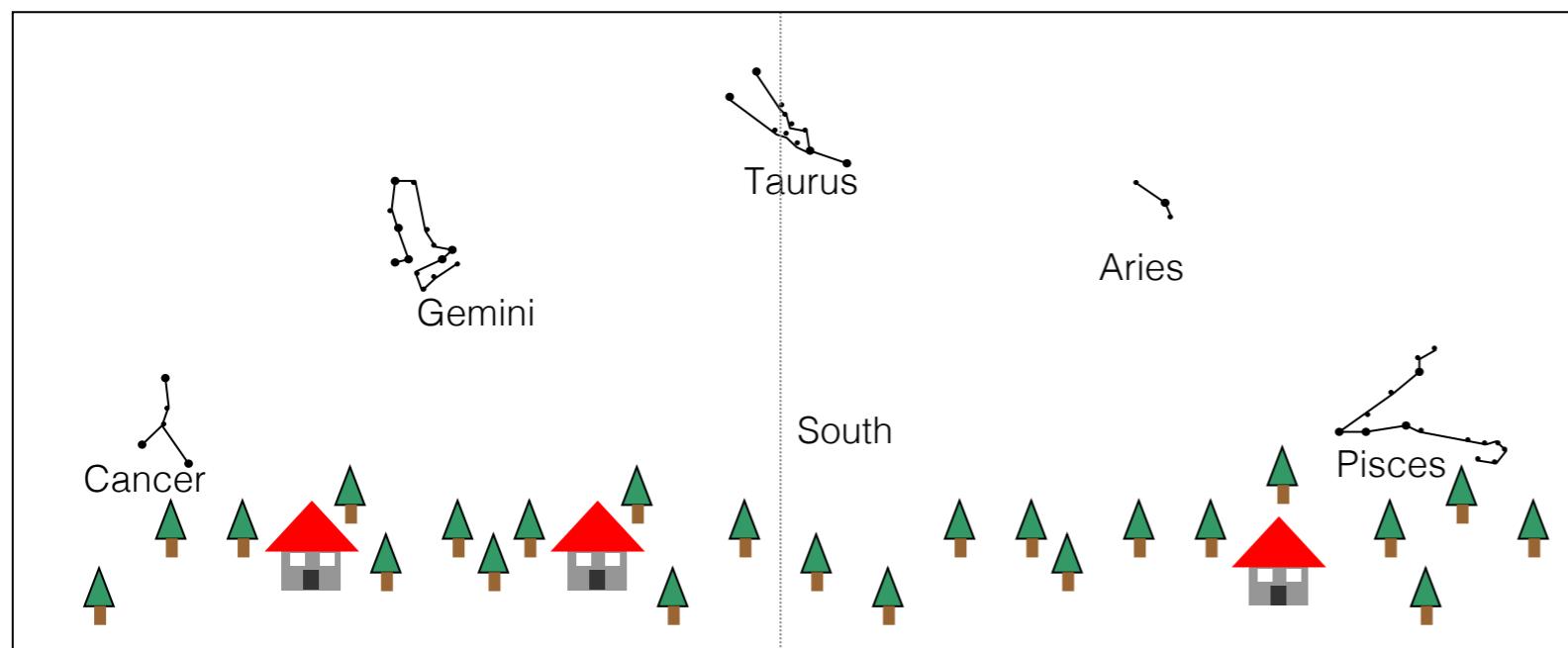


Figure 2 – What it would look like if you were the observer in Figure 1

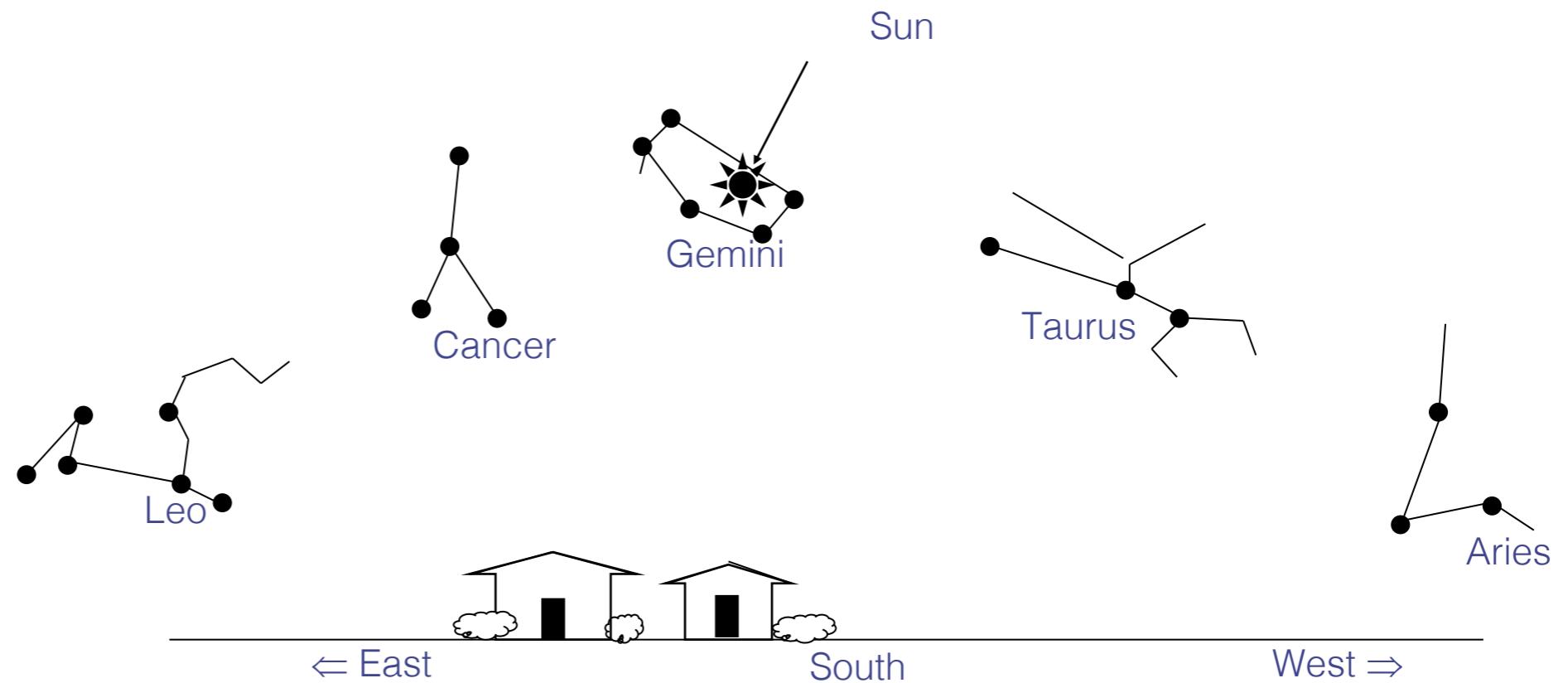
Two months from the time shown what constellation will be high in the Southern sky, at Midnight?

At Noon?

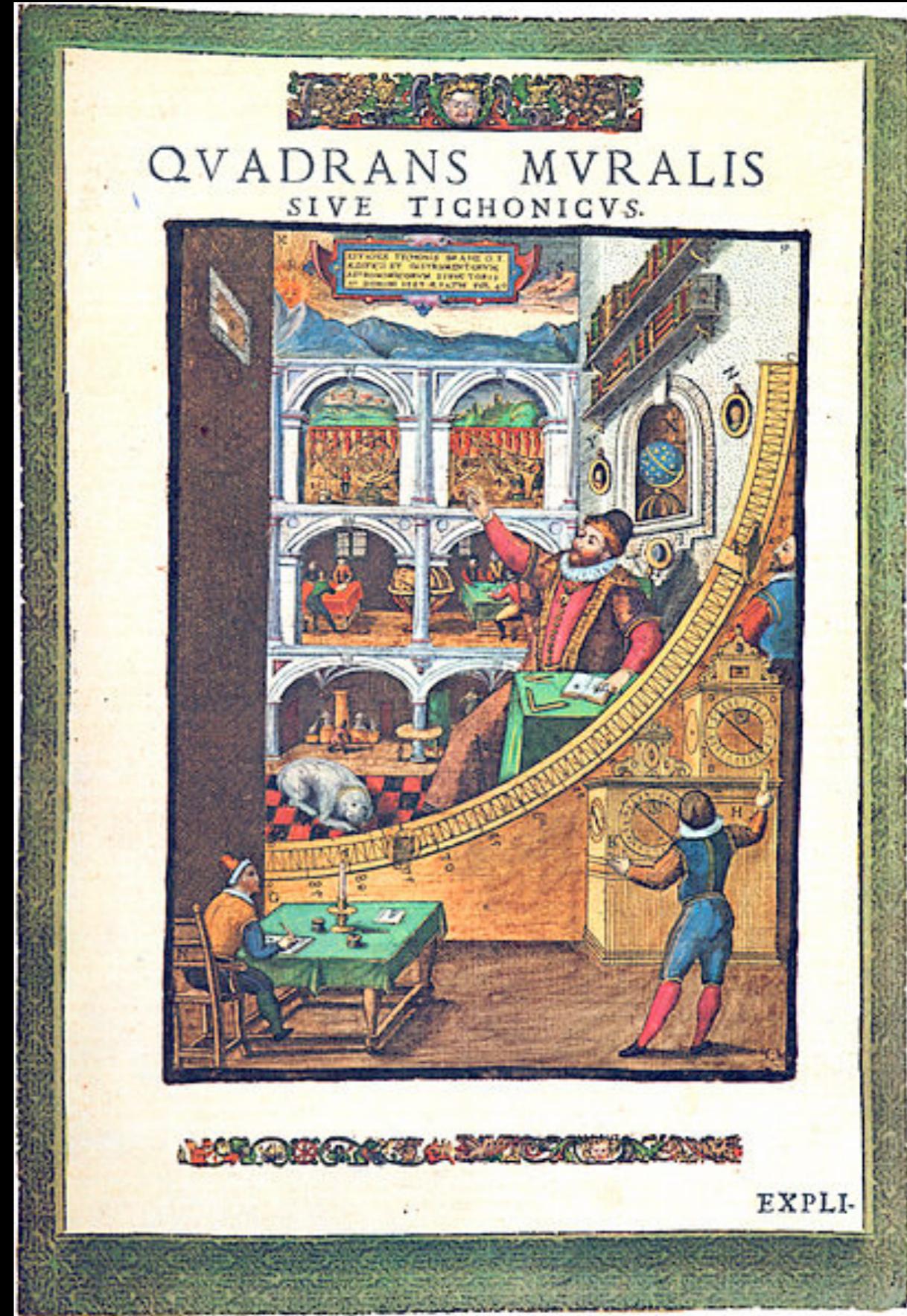
What sign will a person be if they are born at that time?

If you could see stars during the day, the drawing below shows what the sky would look like at noon on a given day. The Sun is near the stars of the constellation Gemini. Near which constellation would you expect the Sun to be located at *sunrise* on this day?

1. Leo
2. Cancer
3. Gemini
4. Taurus
5. Aries



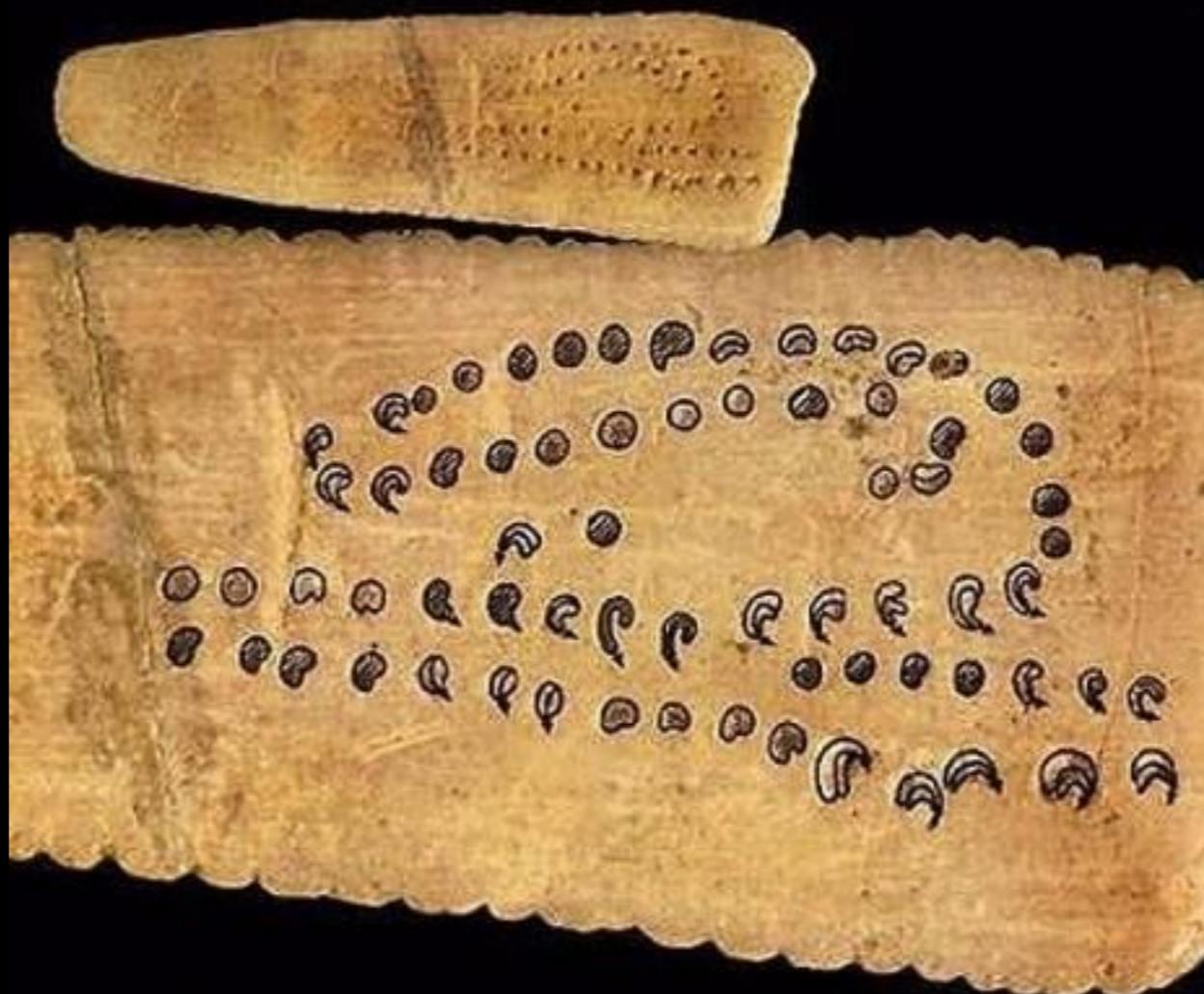
The Origins of Modern Astronomy



Q: From how long ago do you think we have evidence for the study of astronomy?

- A) 100 million BC
- B) 3200 BC
- C) 100 years ago
- D) 1 million BC
- E) 32,000 BC

The Oldest - Marking the Lunar Phases



A bone carving dated to the Aurignacian Culture of Europe, c. **32,000 B.C.** It shows the lunar cycle and its phases.

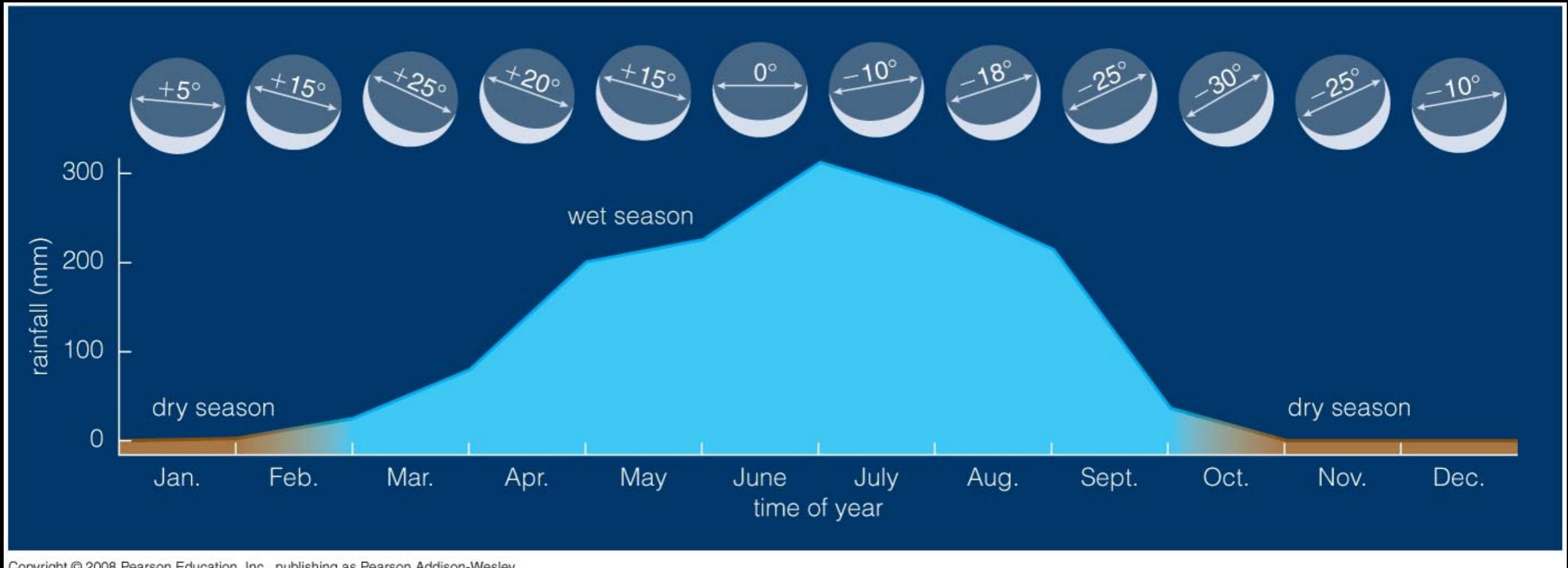
Q: Why would the earliest people want to understand the changes in the night sky?

- A) To know when to plant crops**
- B) Curiosity**
- C) To honor their Gods**
- D) All of the above**



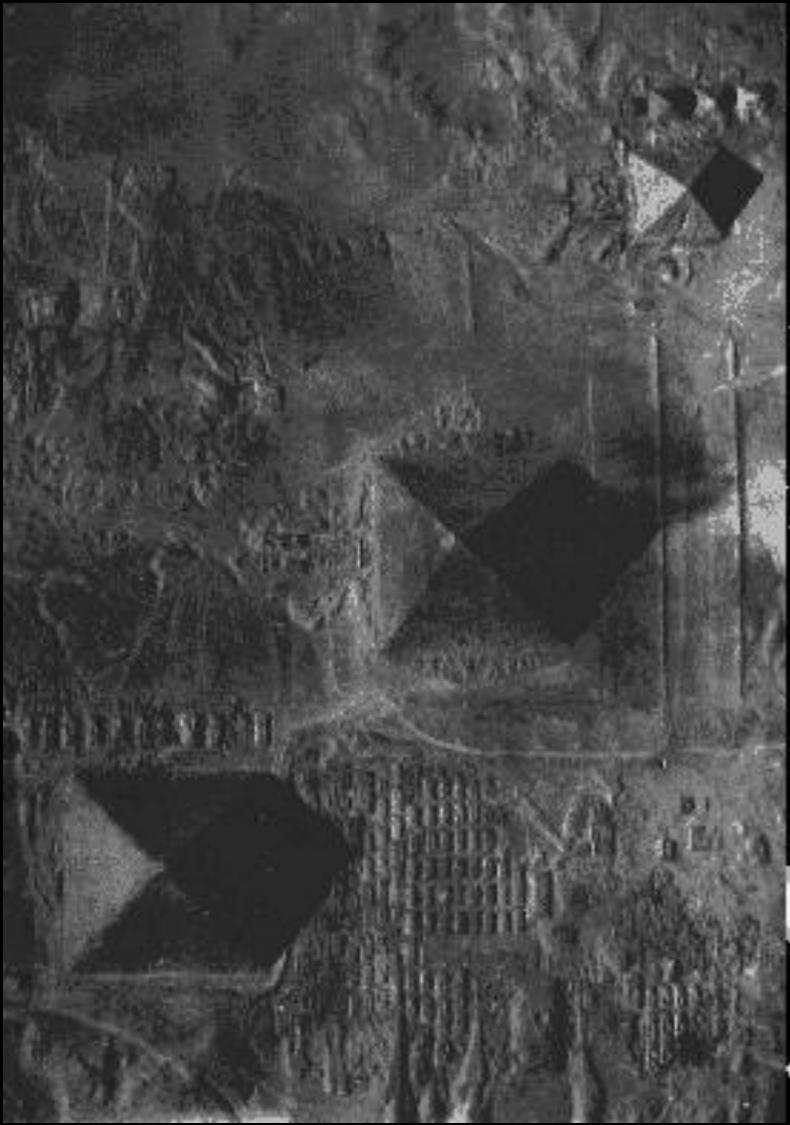
The oldest Astronomy

Tracking the Seasons



Central Africa: c. 6500 B.C. People use the observations of the moon to predict the weather.

Egyptians - paying homage to the gods

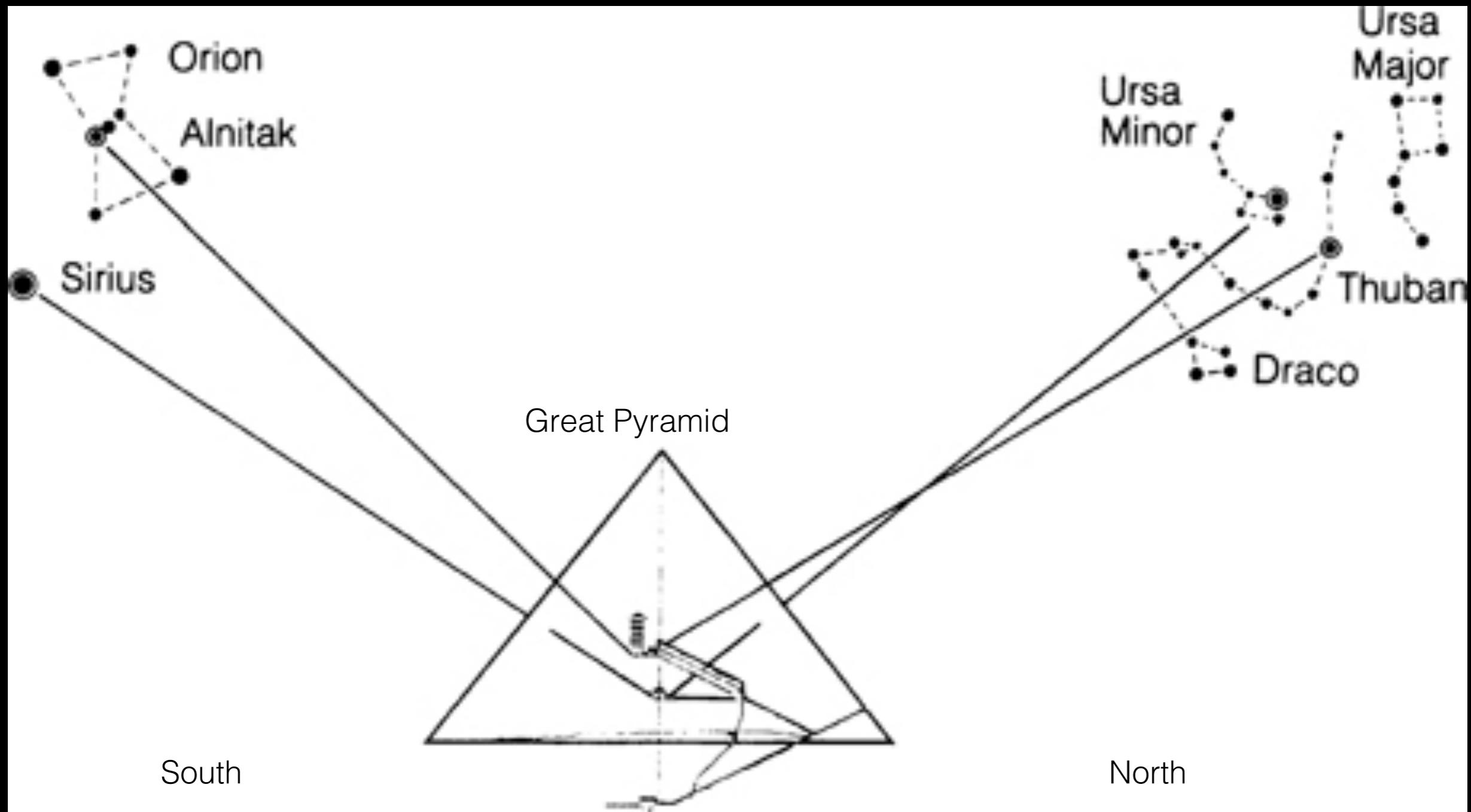


Nut - the
goddess of the
sky

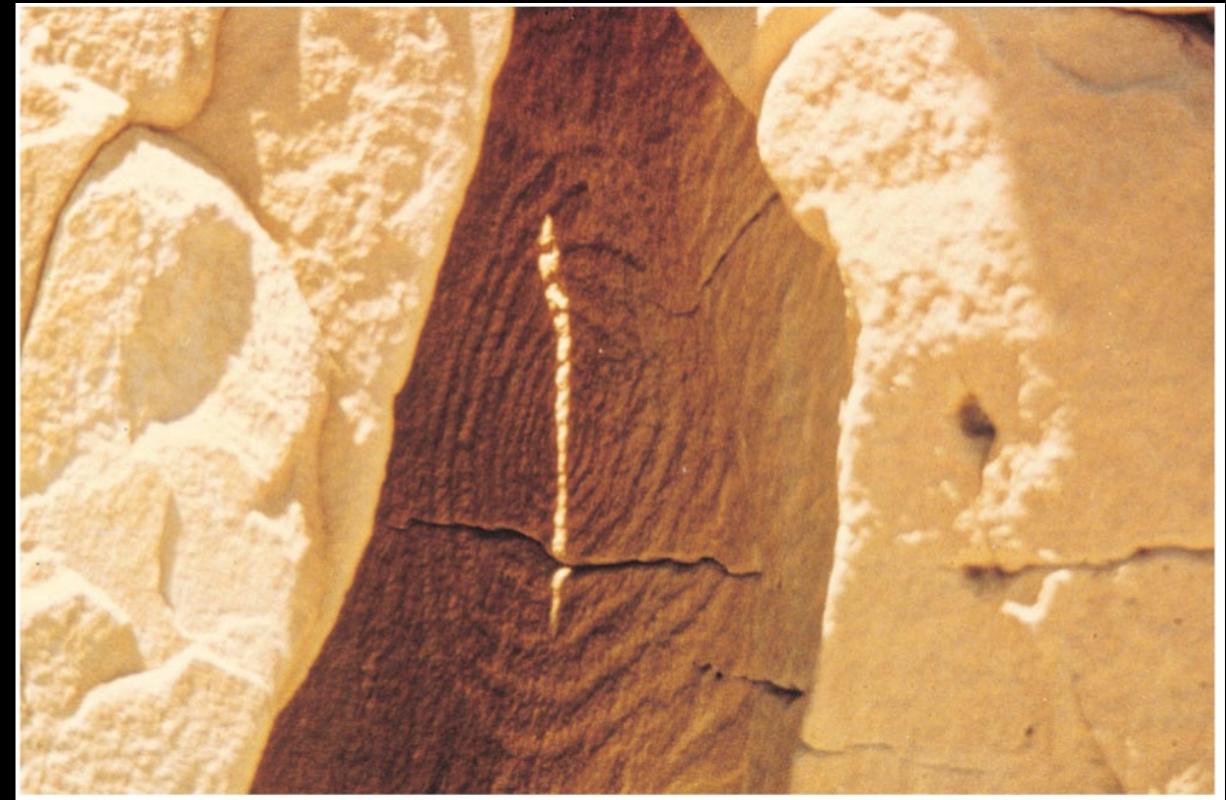
Pyramids of
Giza (C. 2560
BC) align with
the stars in
Orion?



Pyramids built for viewing stellar alignments?



Marking the Solstices and Equinoxes



- Stonehenge (England c. 1500 BC -- and others) had many alignments for solstices, equinoxes and bright stars
- Sun Dagger (New Mexico c. 500-1300 AD) shows noon on summer solstice; other effects in winter & equinoxes

Tracking the Planets and Stars



Mayan observatory, El Caracol, in Chichén Itzá
Mexico had windows placed to allow for
observations of Venus (AD 600-1200).

Macchu Picchu, Peru - c. 1400 AD



The Intihuatana Stone



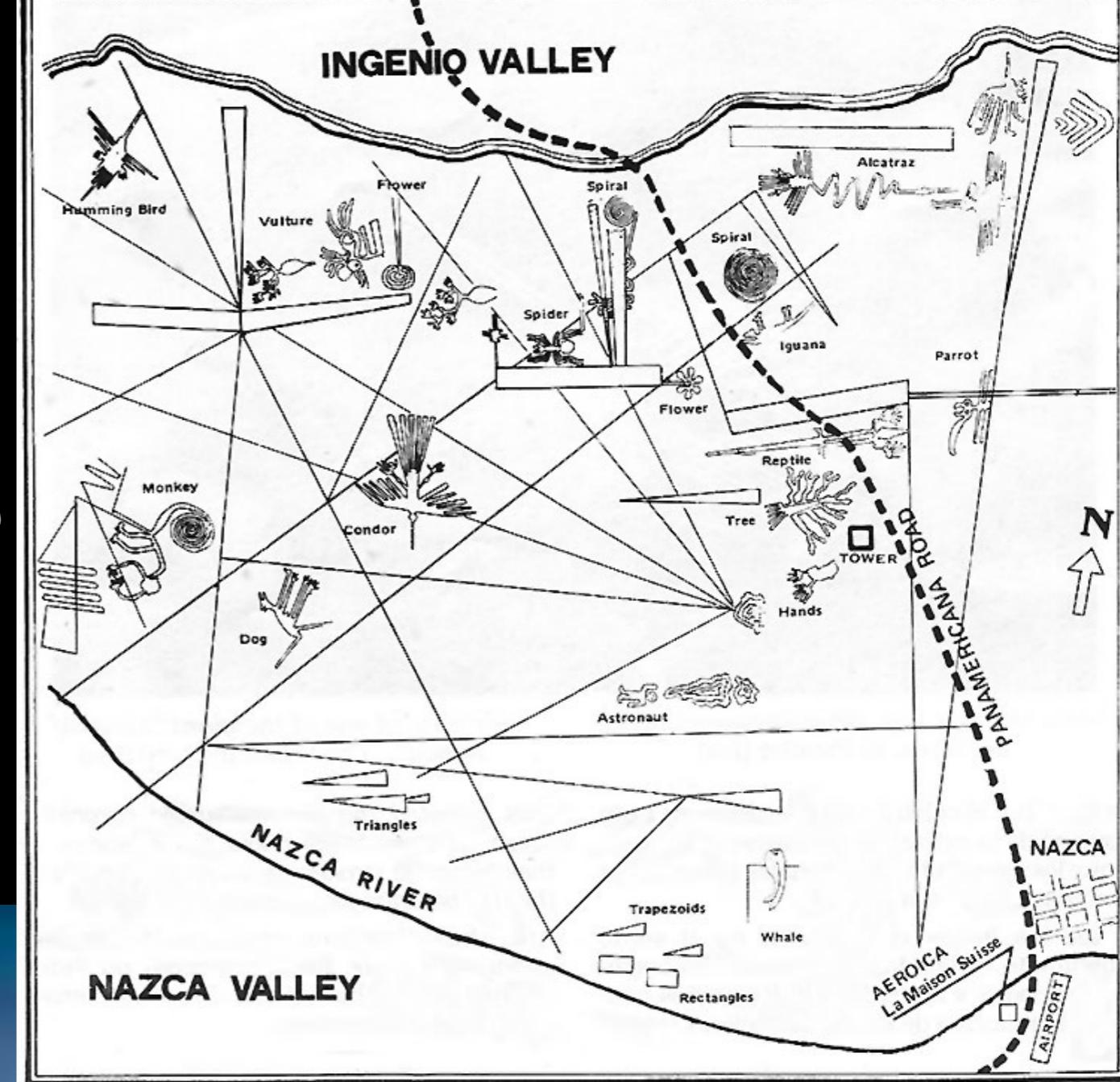
Points at the winter solstice Sun.

Also called the “Hitching Post of the Sun” because, at mid day on the equinoxes, the pillar casts no shadow.

Also ...

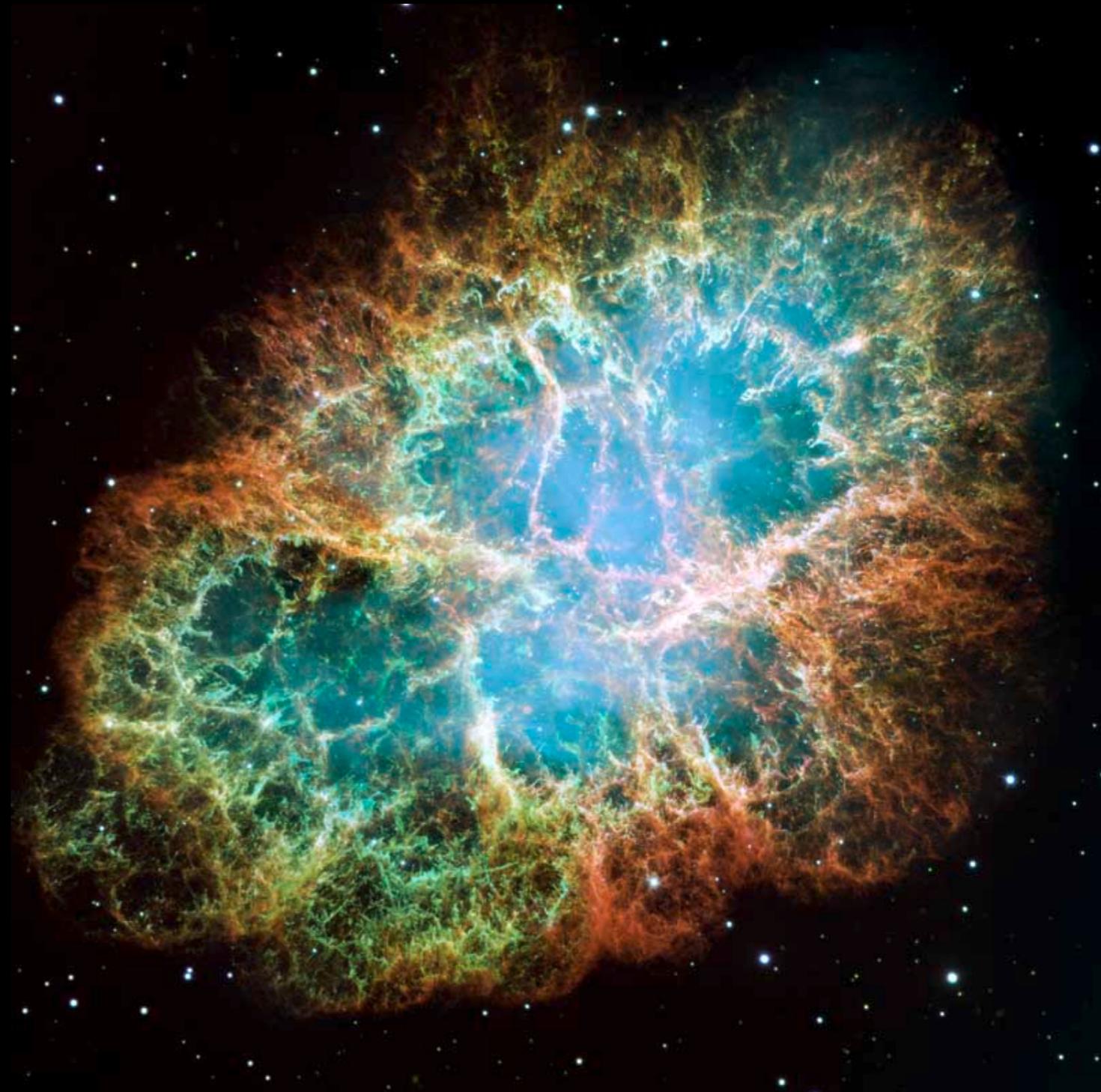
Nasca lines, Peru - large figures of animals may have represented constellations to the Incas who lived there (400-650 AD).

The Big Horn Medicine Wheel in Wyoming - may have been related to the months for the Native Americans (AD?)



A new star in the sky ...

- Ancient Chinese Astronomers kept very detailed records of astronomical observations beginning 5,000 years ago.
- They were the first to record an observation of a Supernova explosion, which we see today as the **Crab Nebula** - 1054 AD



A new star in the sky ...

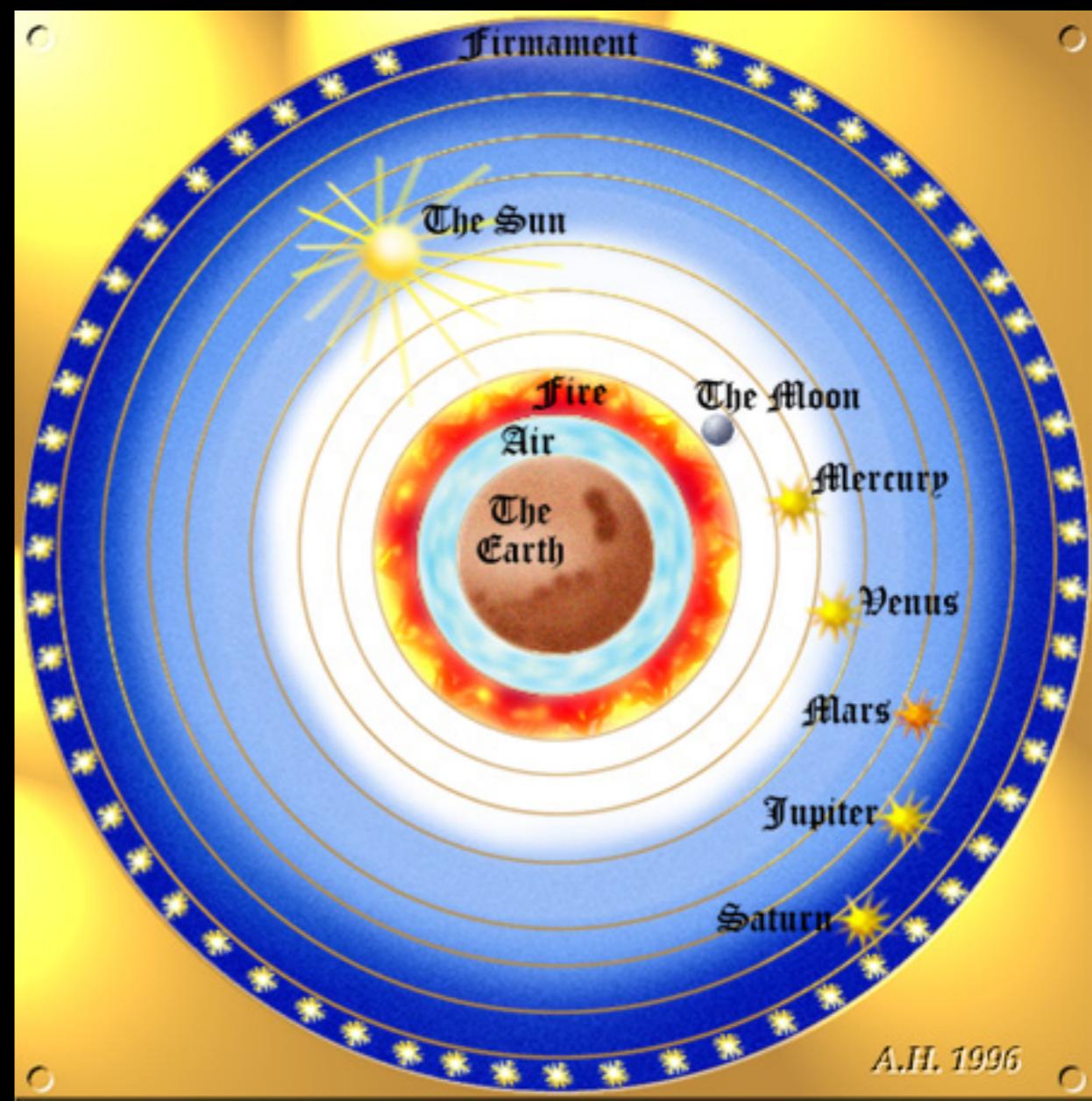


The Native Americans in Chaco Canyon, AZ may have seen it too (1054 AD)

Aristotle: 384-322 BC

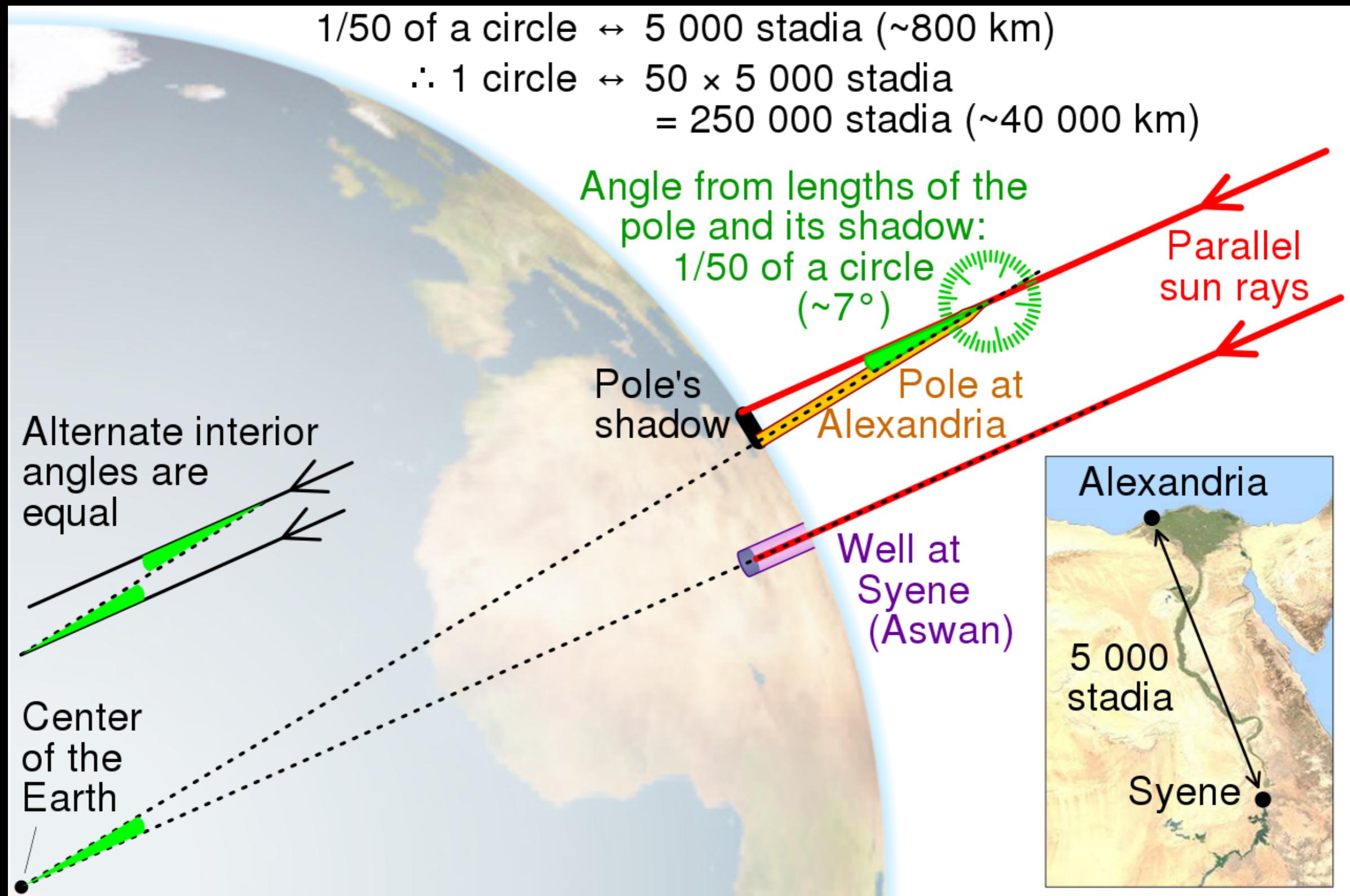
He believed as a first principle that the heavens were perfect, vs. the imperfect terrestrial realm (change, decay, etc on Earth).

He also believed that all motion in the perfect heavens must be caused by the rotation of spheres carrying objects around in uniform circular motion.



Eratosthenes: ~200 BC

He was able to measure the size of the Earth!



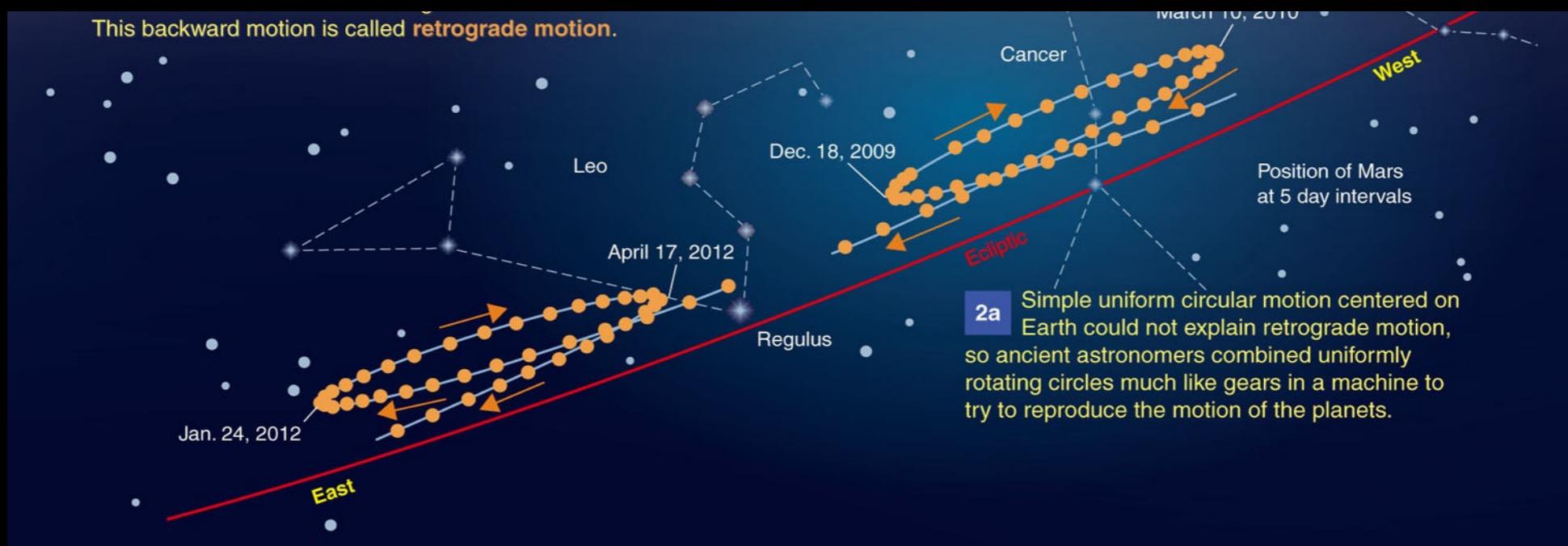
In General, Ancient Astronomers

Accepted without question that:

- Heavenly objects must move on circular paths at constant speeds.
- Earth is motionless at the center of the universe

However, as viewed from Earth, the planets seem to follow complicated paths in the sky.

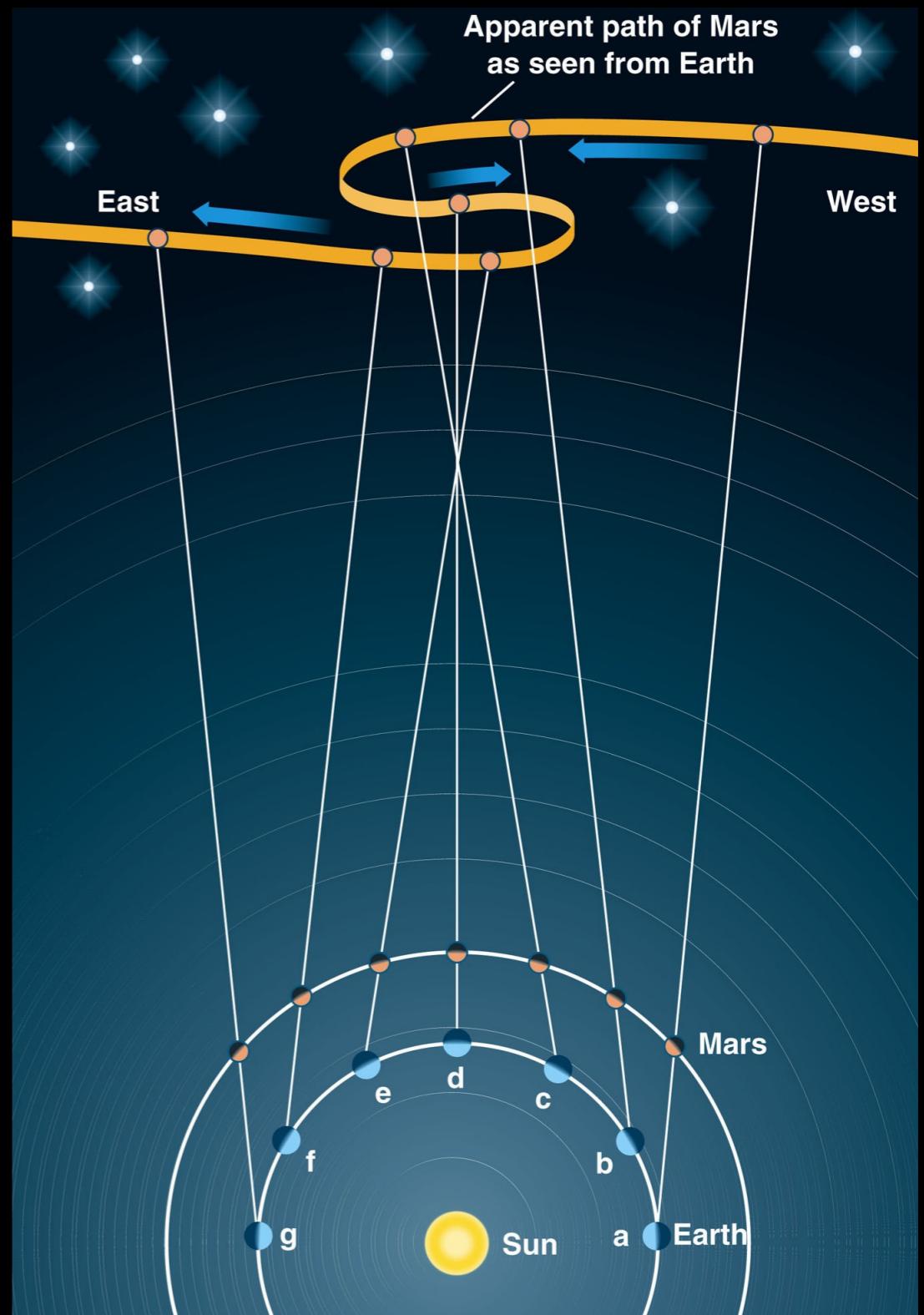
- These include episodes of ‘backward’ motion that are difficult to explain in terms of motion on circular paths at constant speeds.



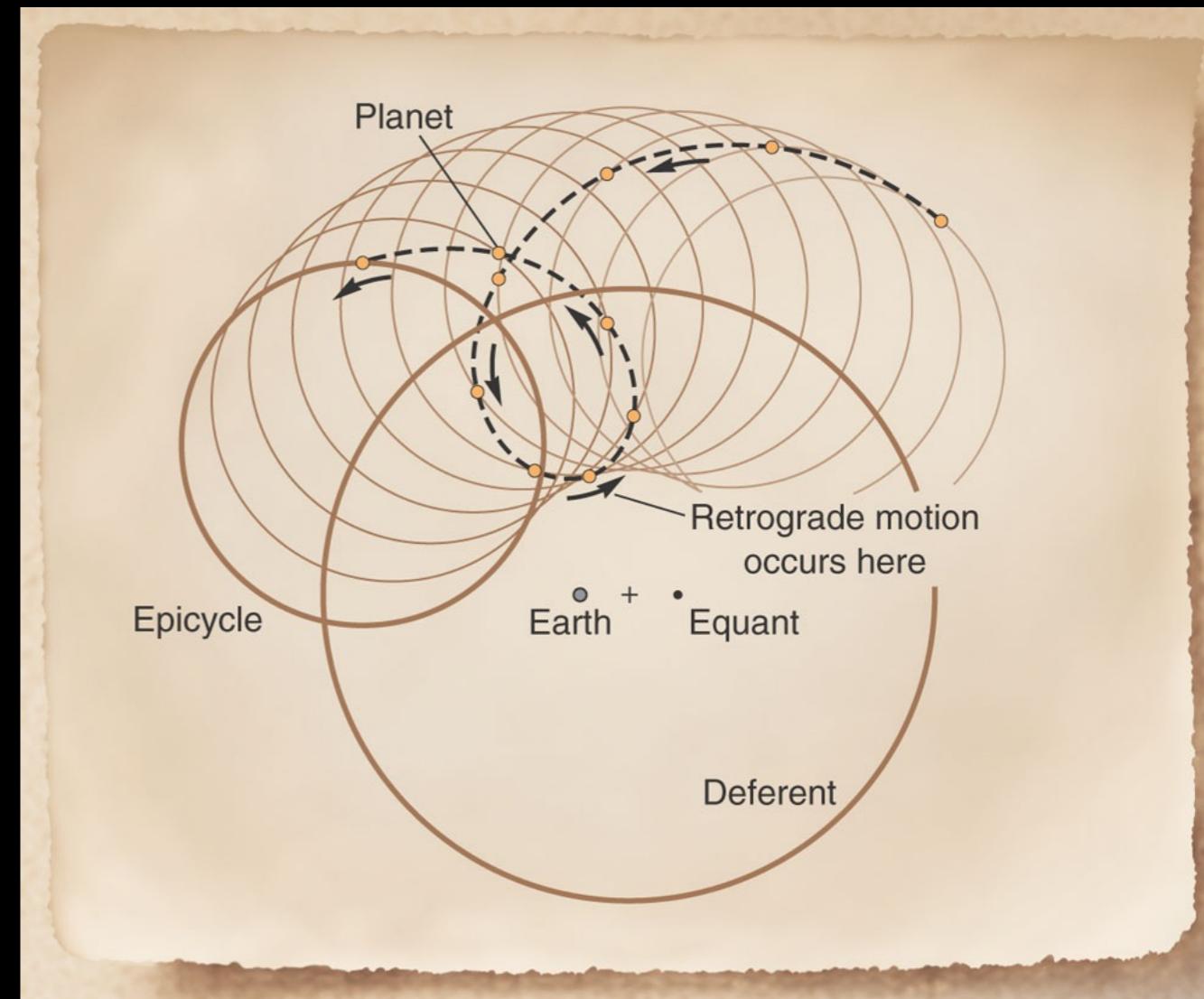
Retrograde Motion

Earth moves faster along its orbit than the planets that lie farther from the sun.

- Consequently, it periodically overtakes and passes these planets.
- i.e. the retrograde motion of Mars



- Ptolemy: 140 AD
 - set about making an accurate **mathematical** description of the motions of the planets.
 - Moved Earth a little off-center in the model slightly varied the planets' speeds.
 - His model is called the “Earth-centered” or “**geo-centric**” model





The astronomer must try his utmost to explain celestial motions by the simplest possible hypothesis; but if he fails to do so, he must choose whatever other hypotheses meet the case.

-Ptolemy of Alexandria
(140 A.D.)



Ptolemy was -

Ptolemy was :

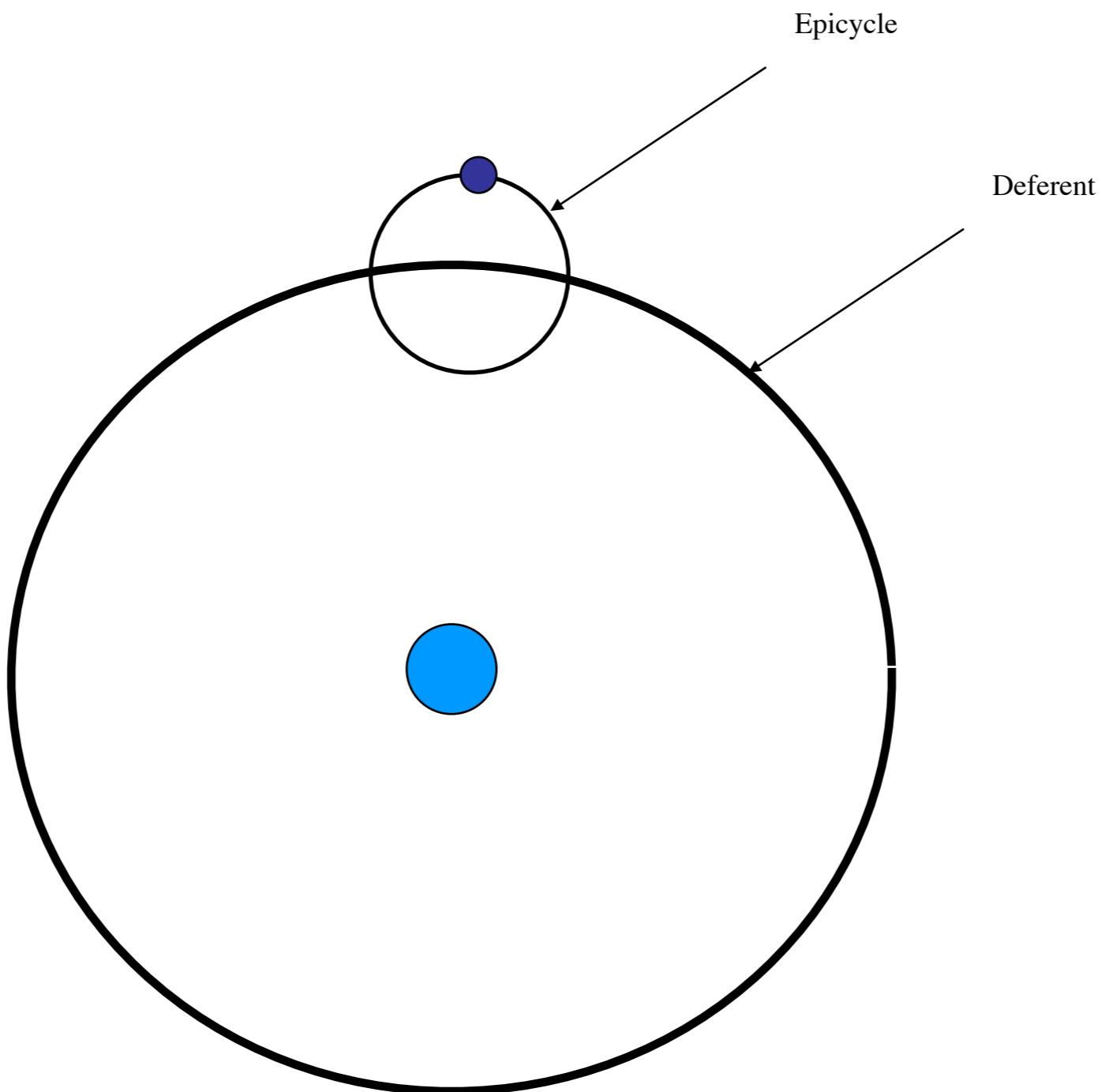
1. Polish
2. Danish
3. Italian
4. German
5. Greek



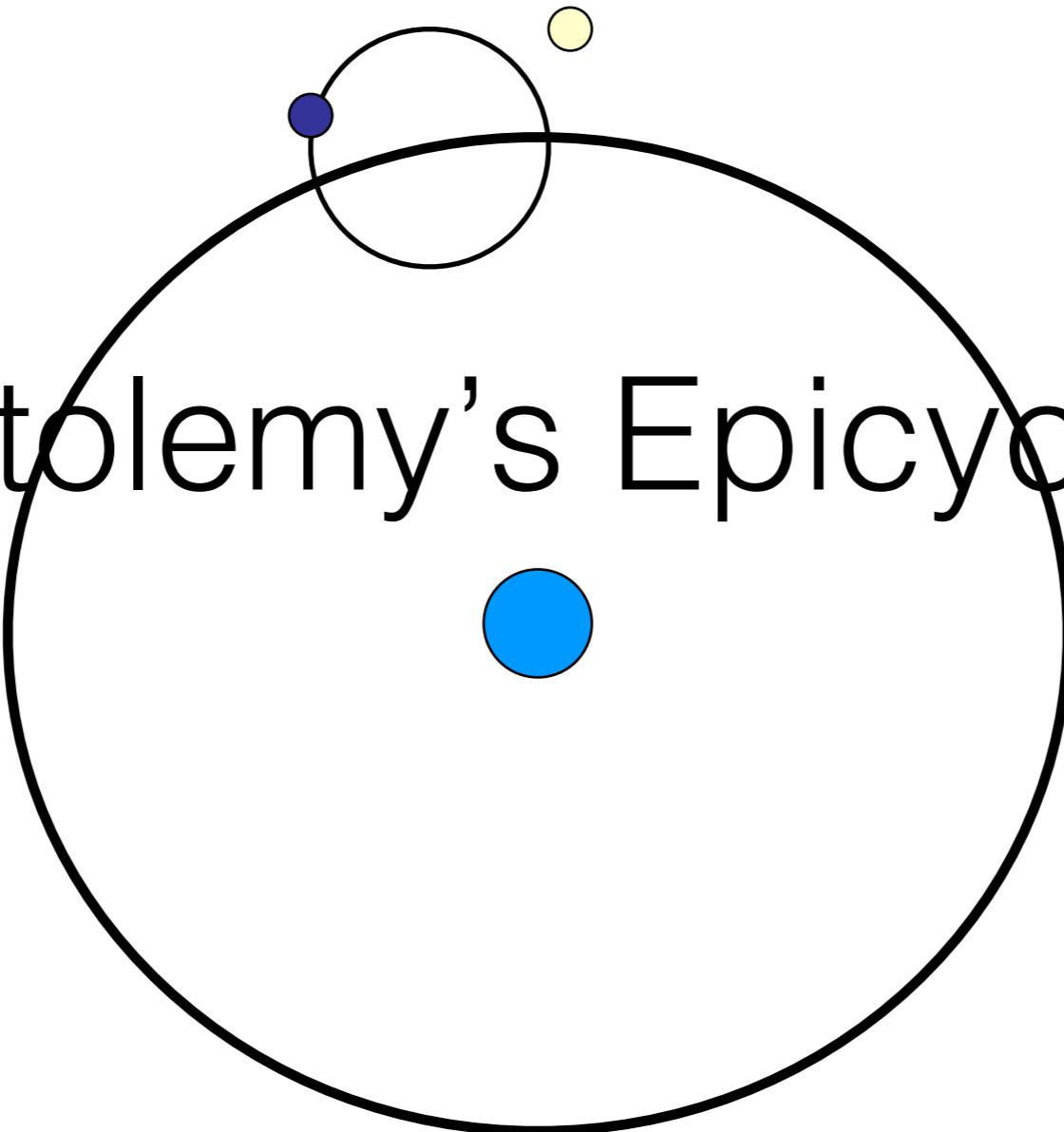
Ptolemy tried to create a model
that would account for
retrograde motion.

He placed the planets in orbits
(deferments) on orbits
(epicycles) all around the Earth

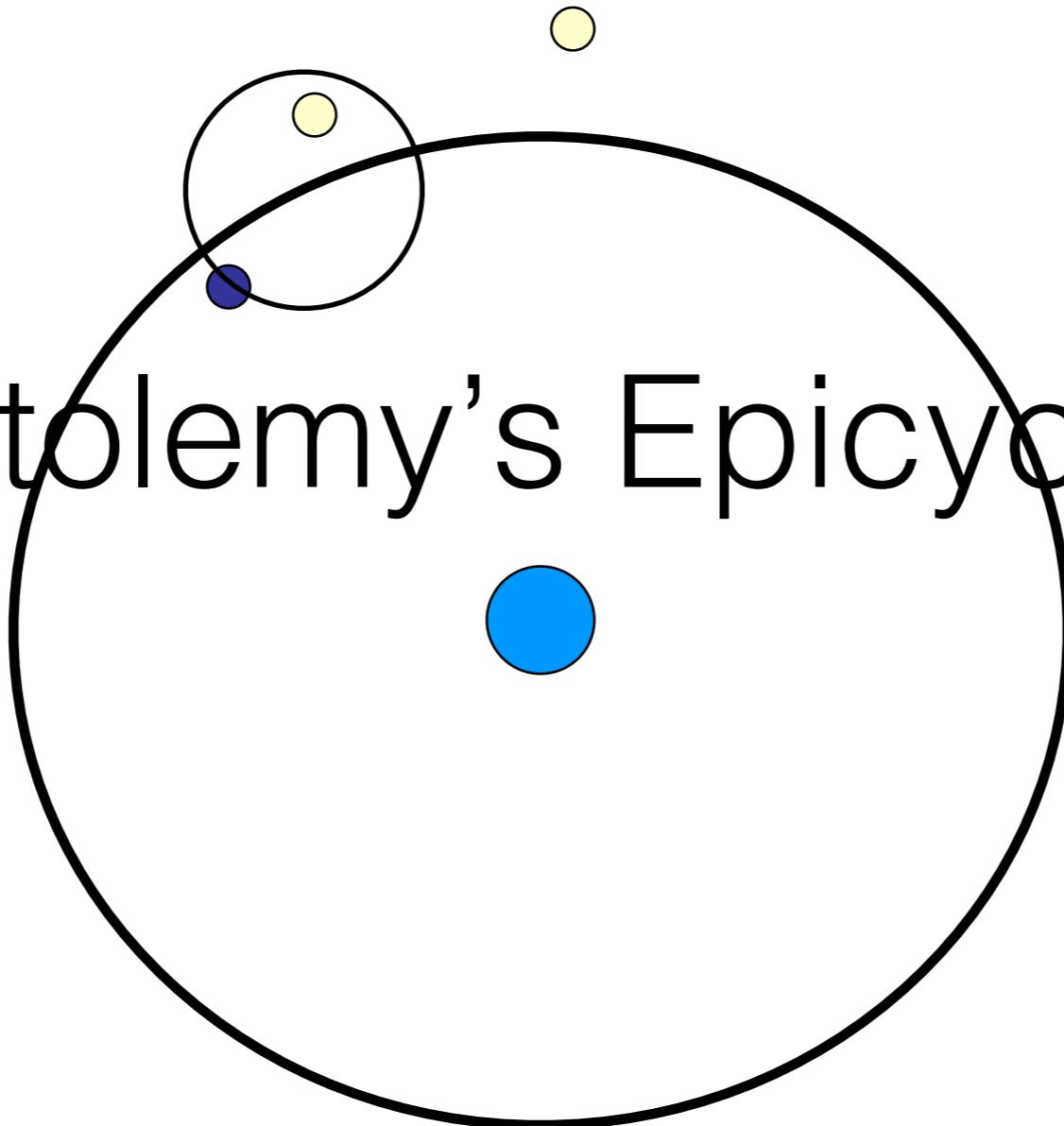
Ptolemy's Epicycles



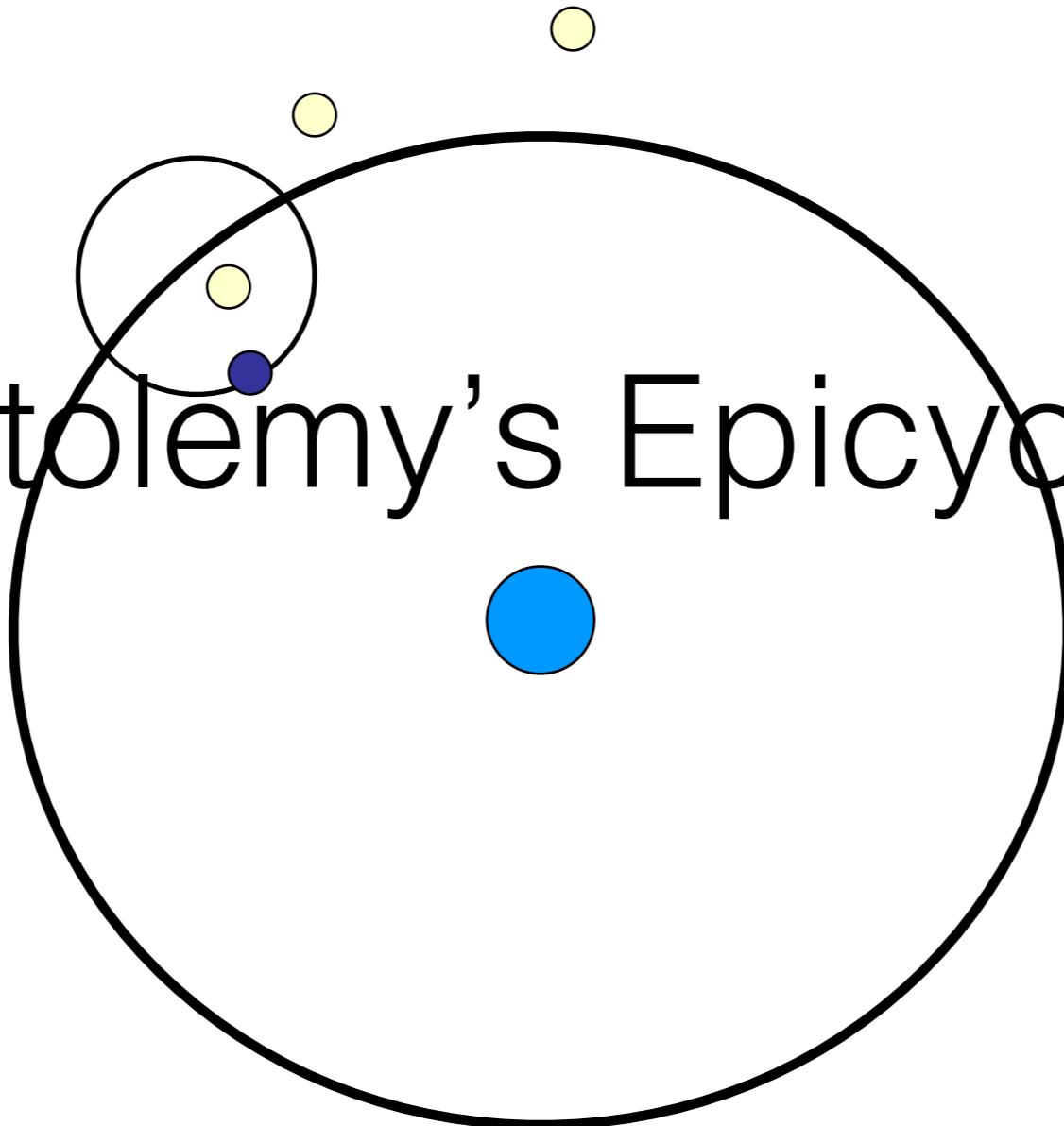
Ptolemy's Epicycles

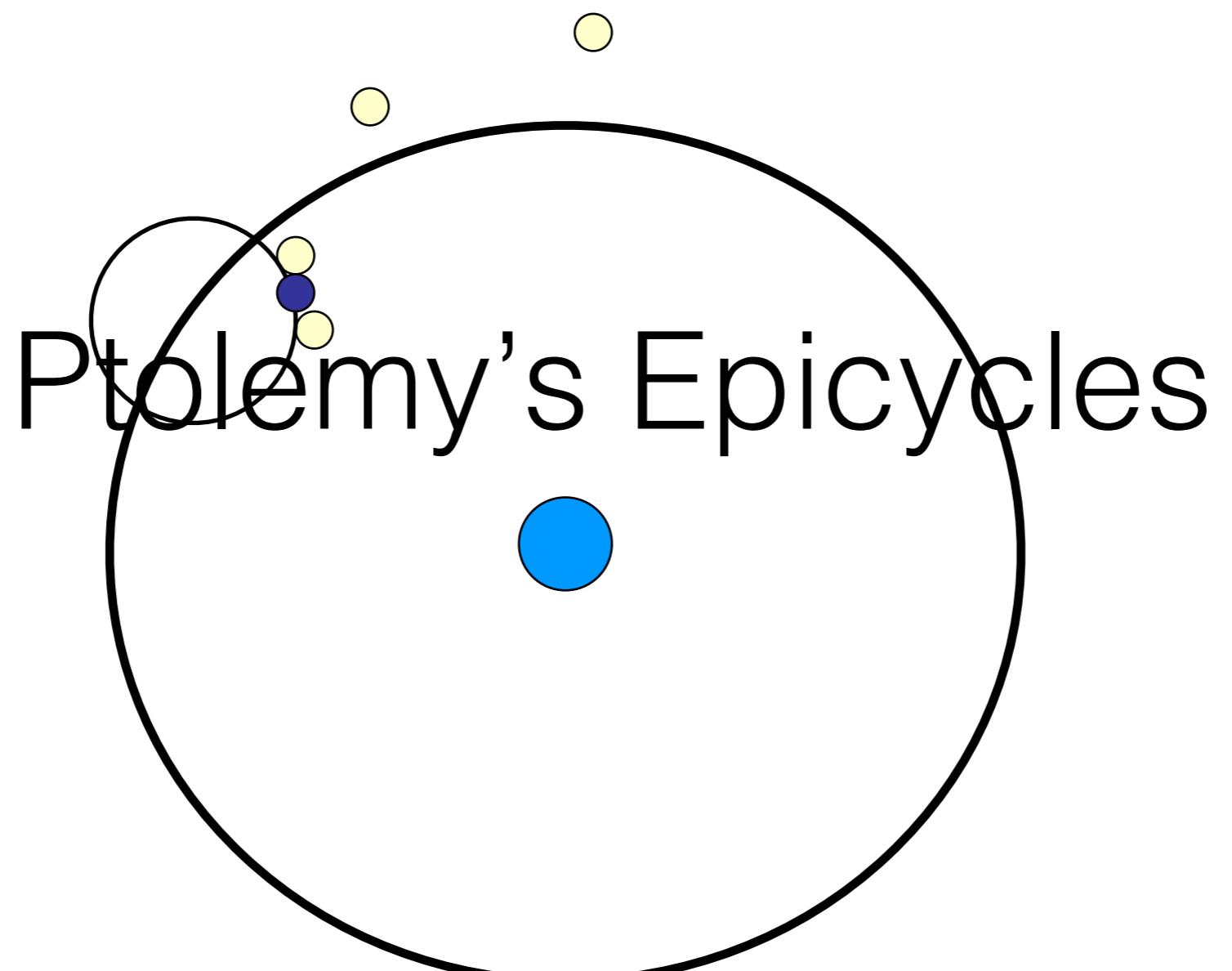


Ptolemy's Epicycles



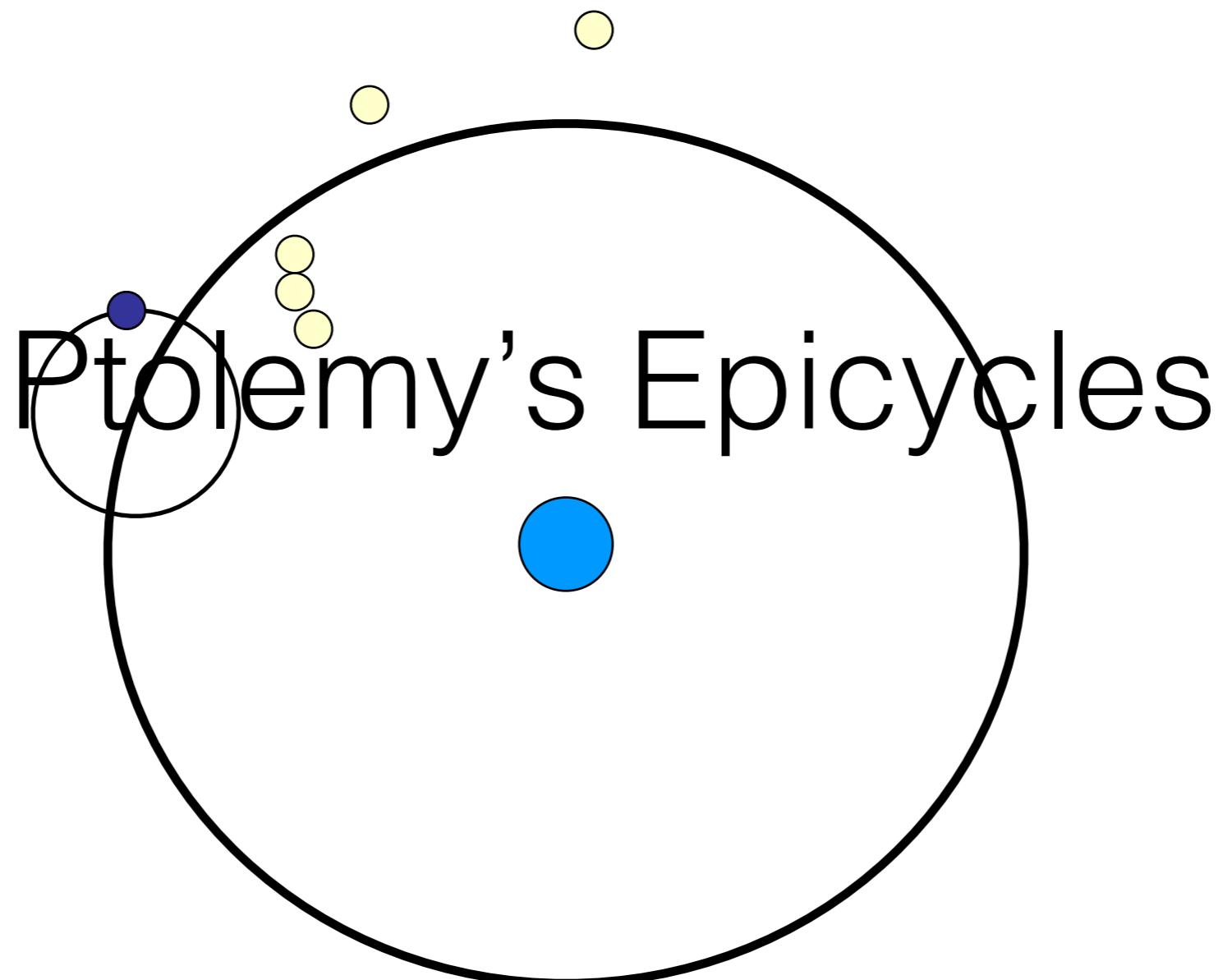
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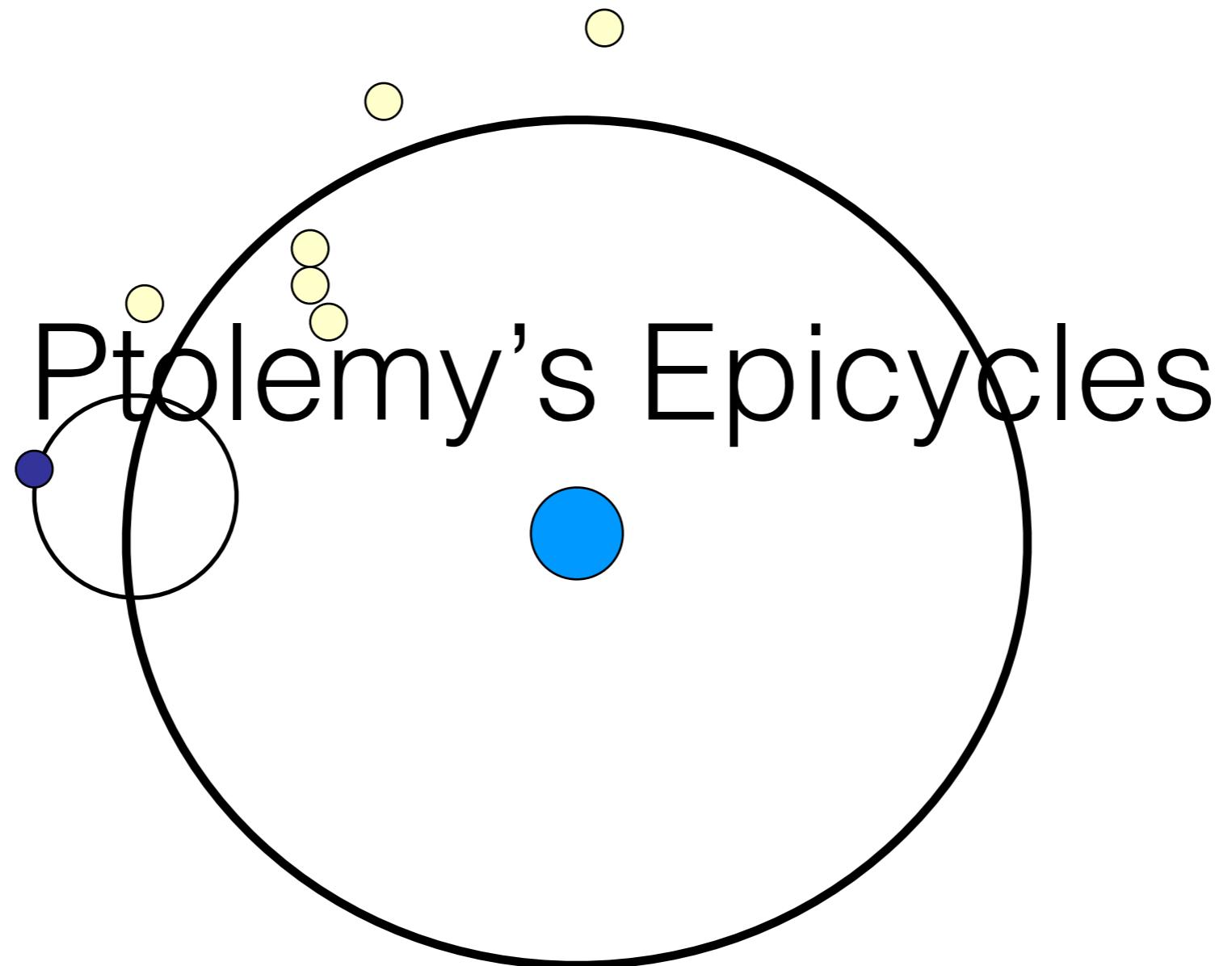


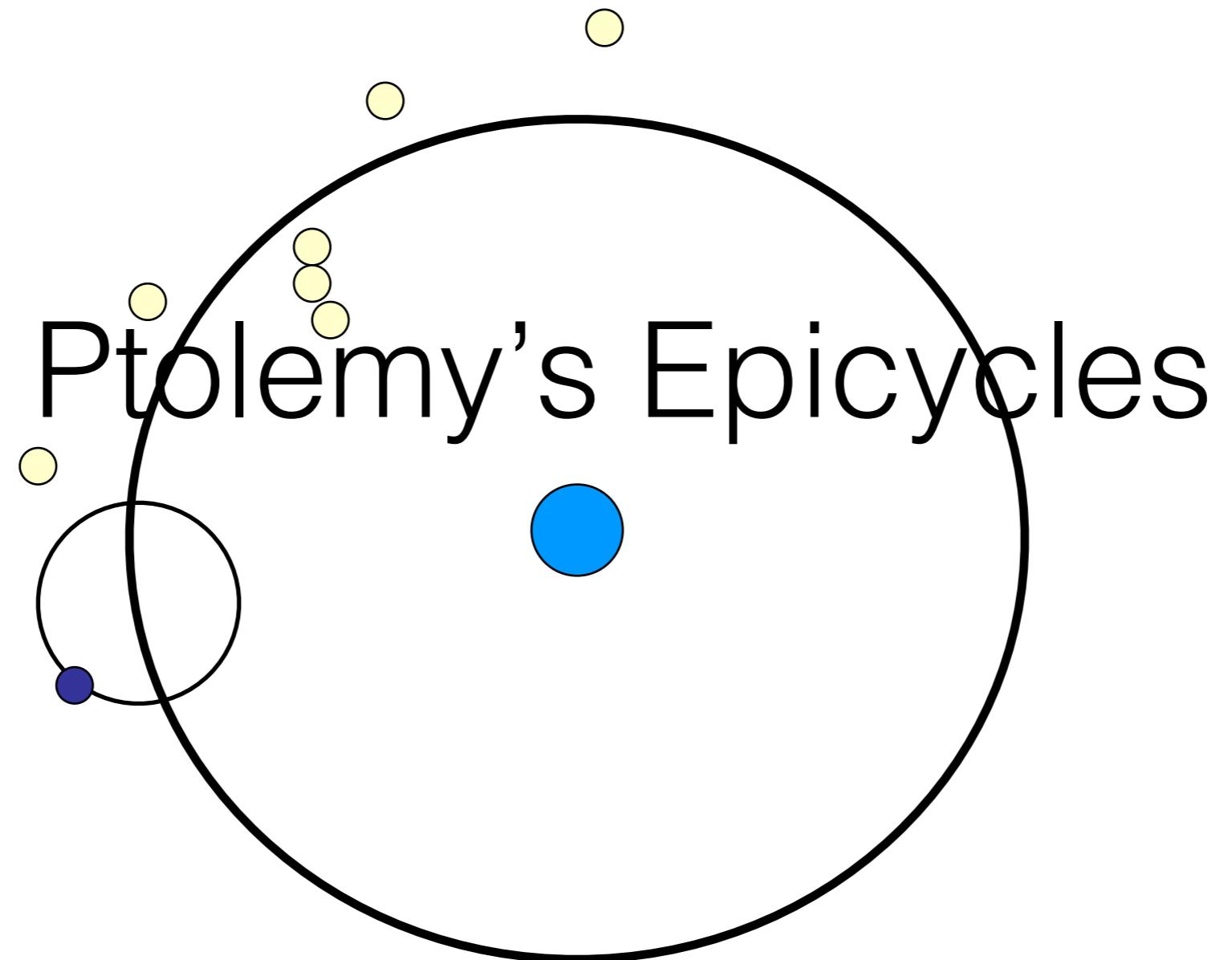


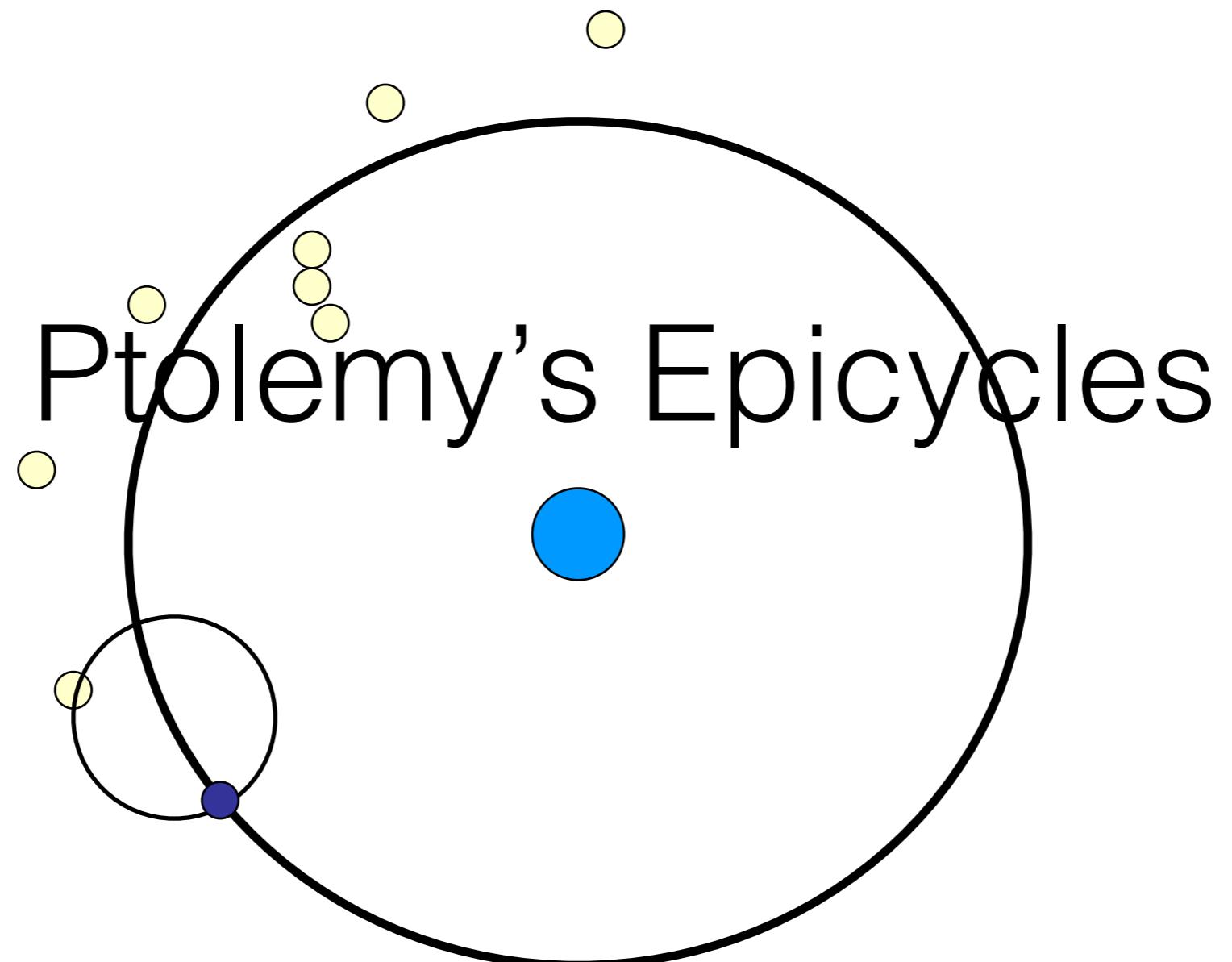
A diagram illustrating Ptolemy's model of celestial motion using epicycles. A large black circle represents the deferent. Inside it, a smaller blue circle represents the center of the epicycle. A point on the epicycle's circumference traces a path across the deferent. Four small yellow circles represent the planets: one is at the center of the epicycle, and three others are positioned along the path it traces.

Ptolemy's Epicycles

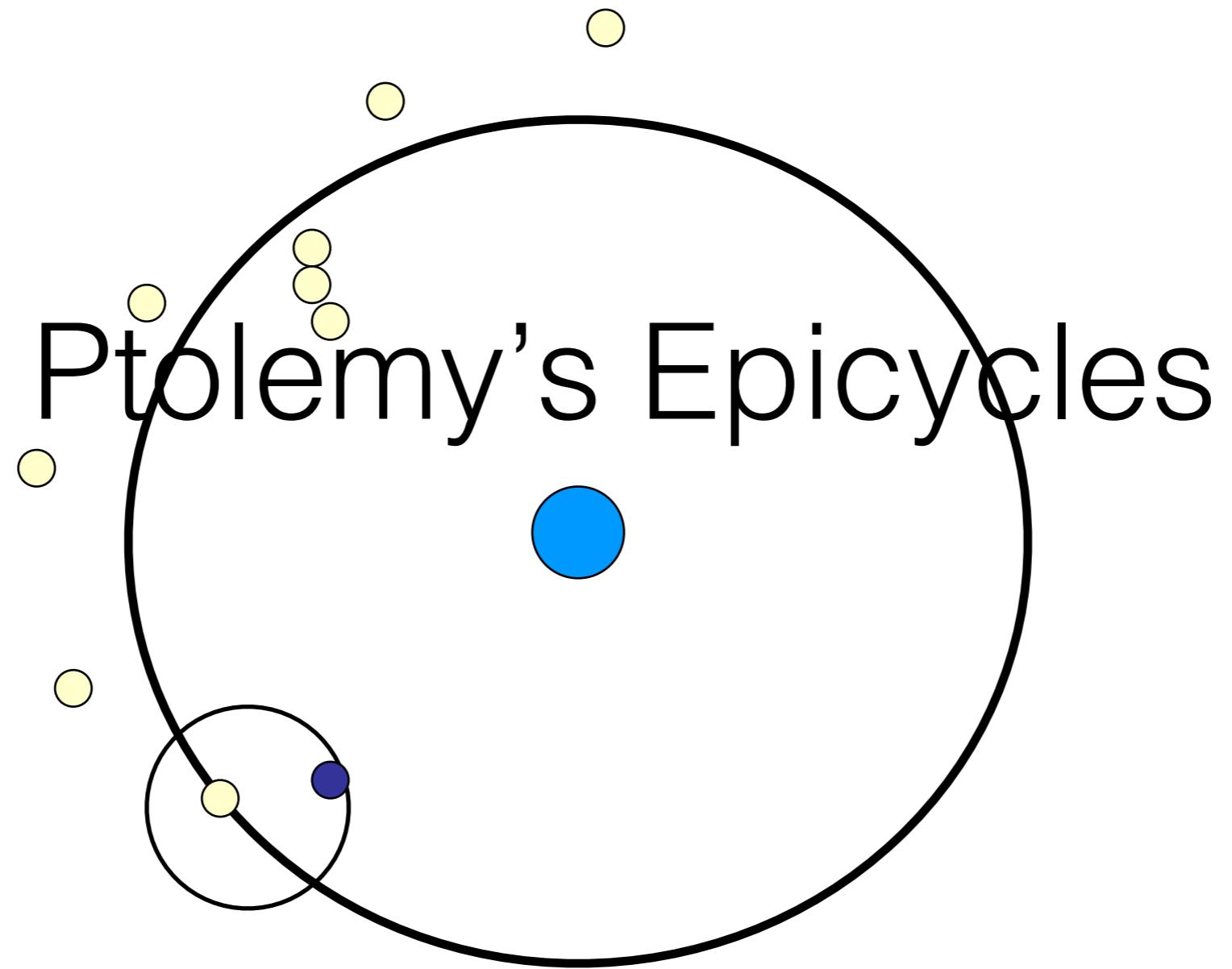




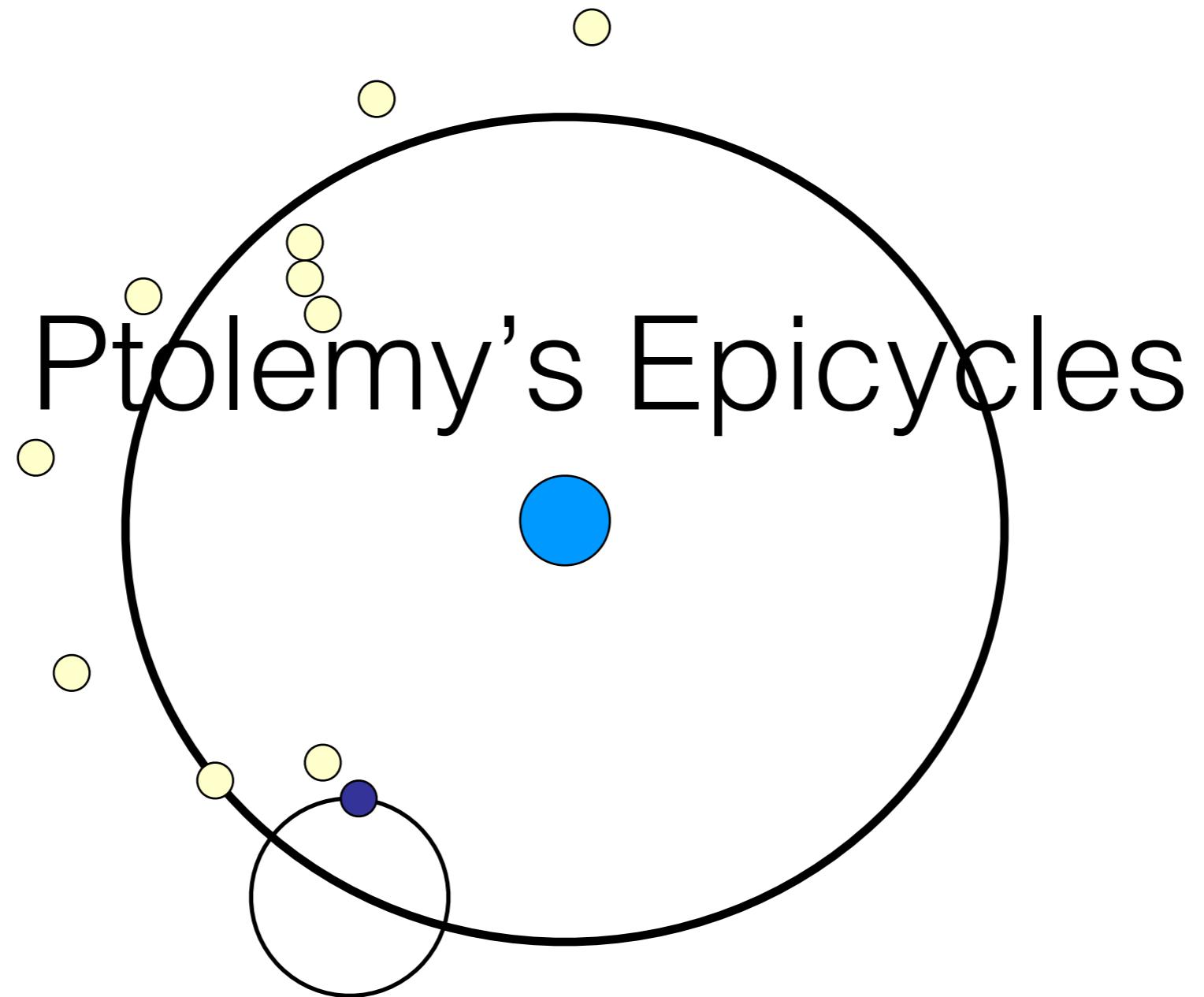




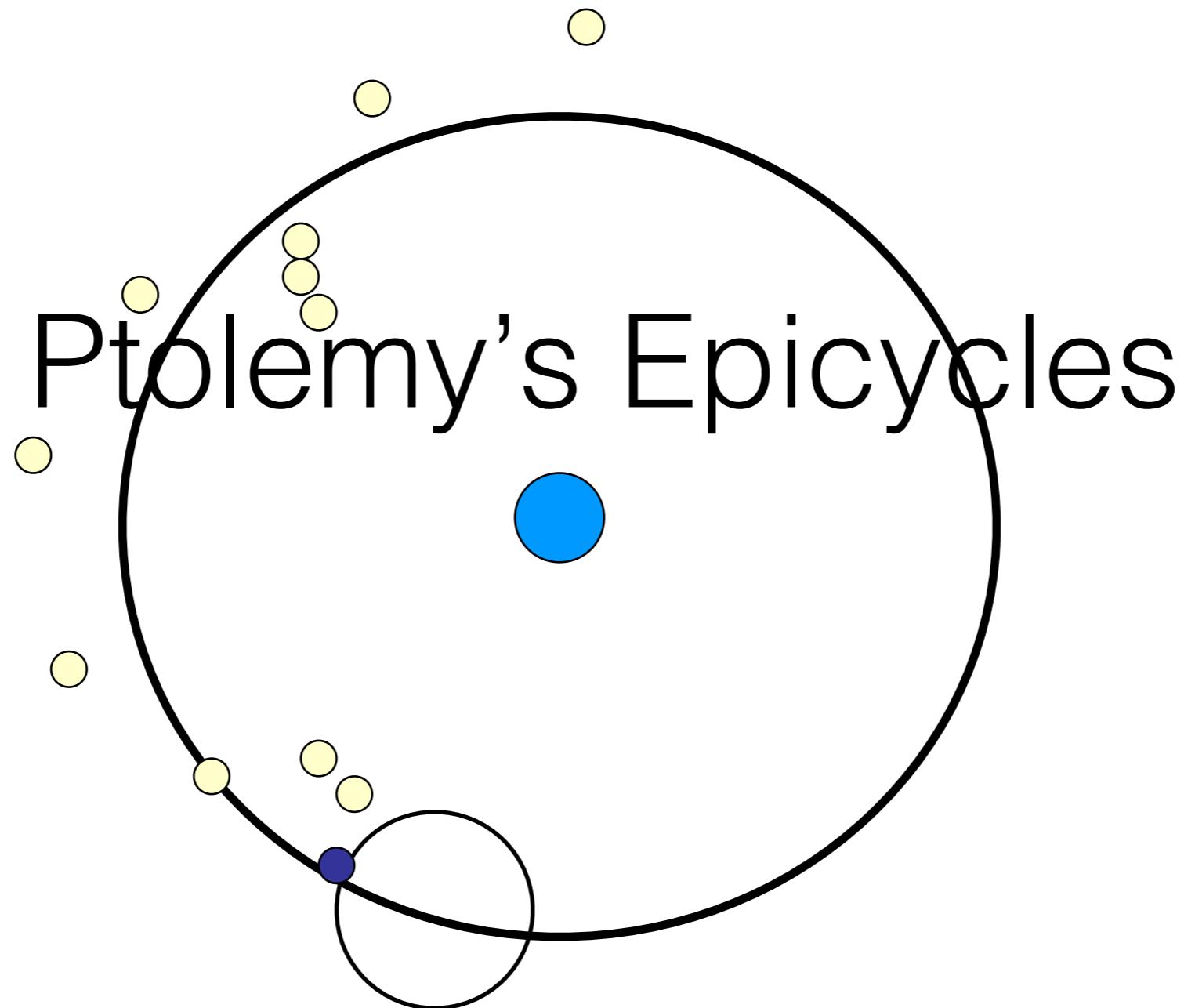
Ptolemy's Epicycles



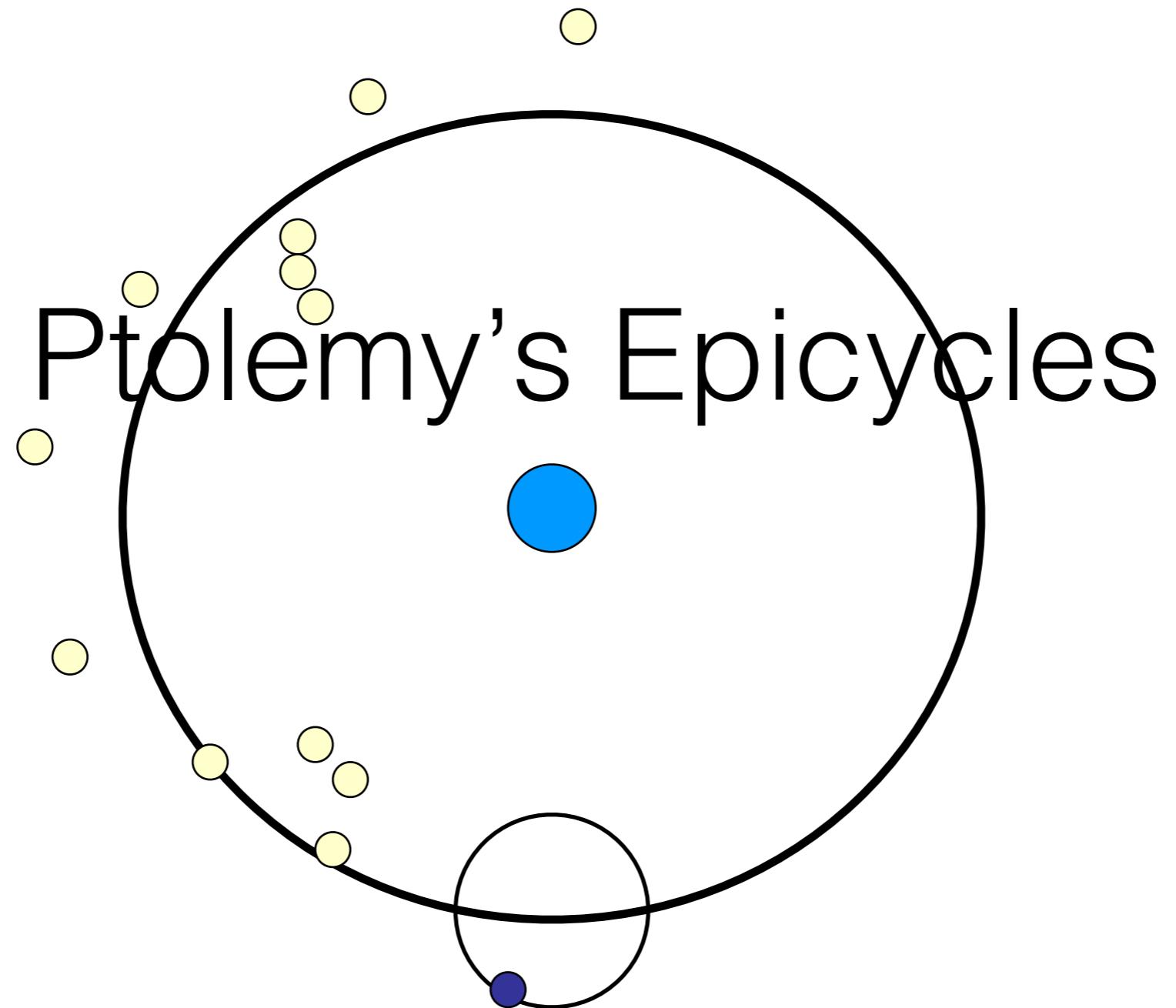
Ptolemy's Epicycles

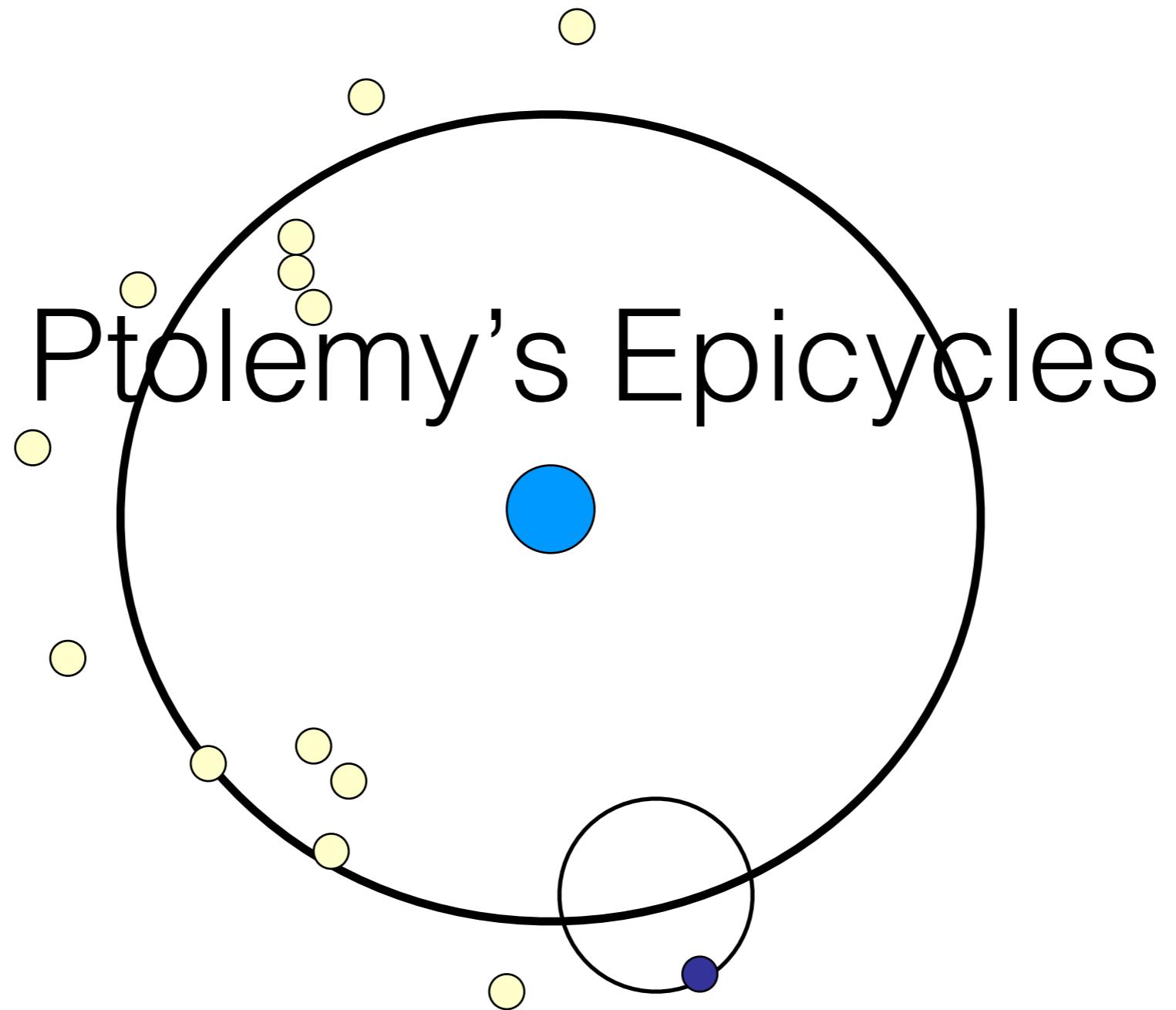


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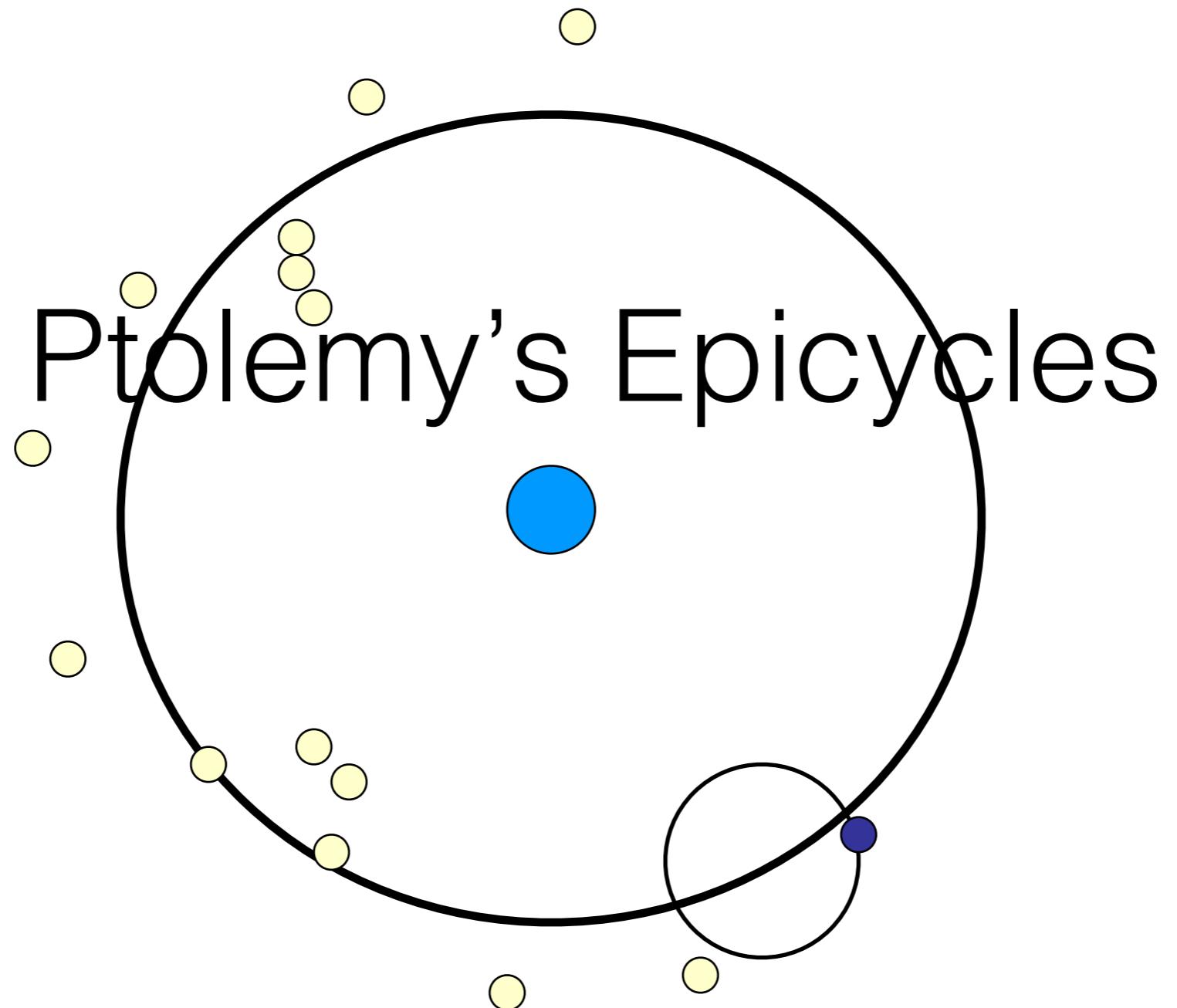


Ptolemy's Epicycles

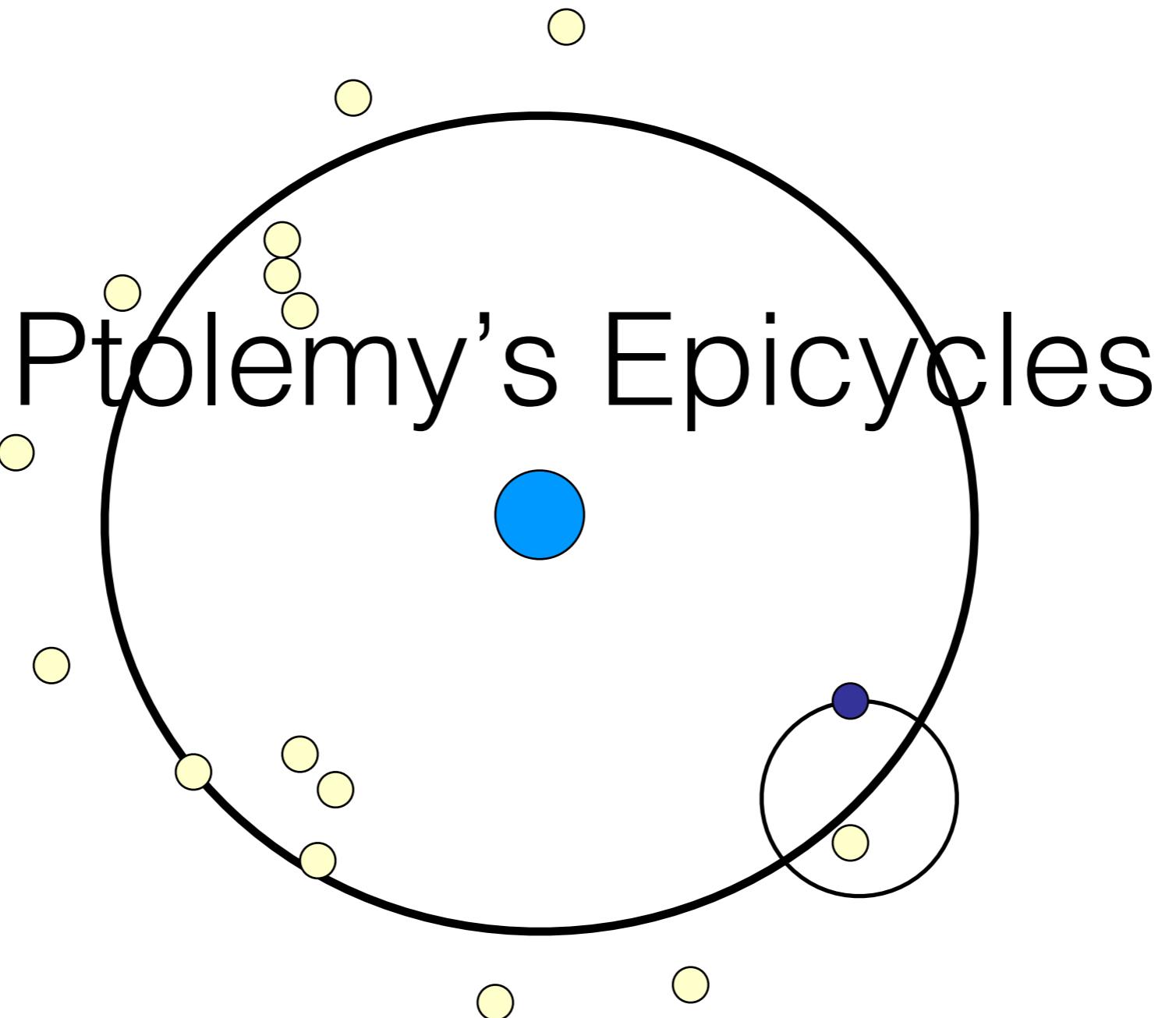




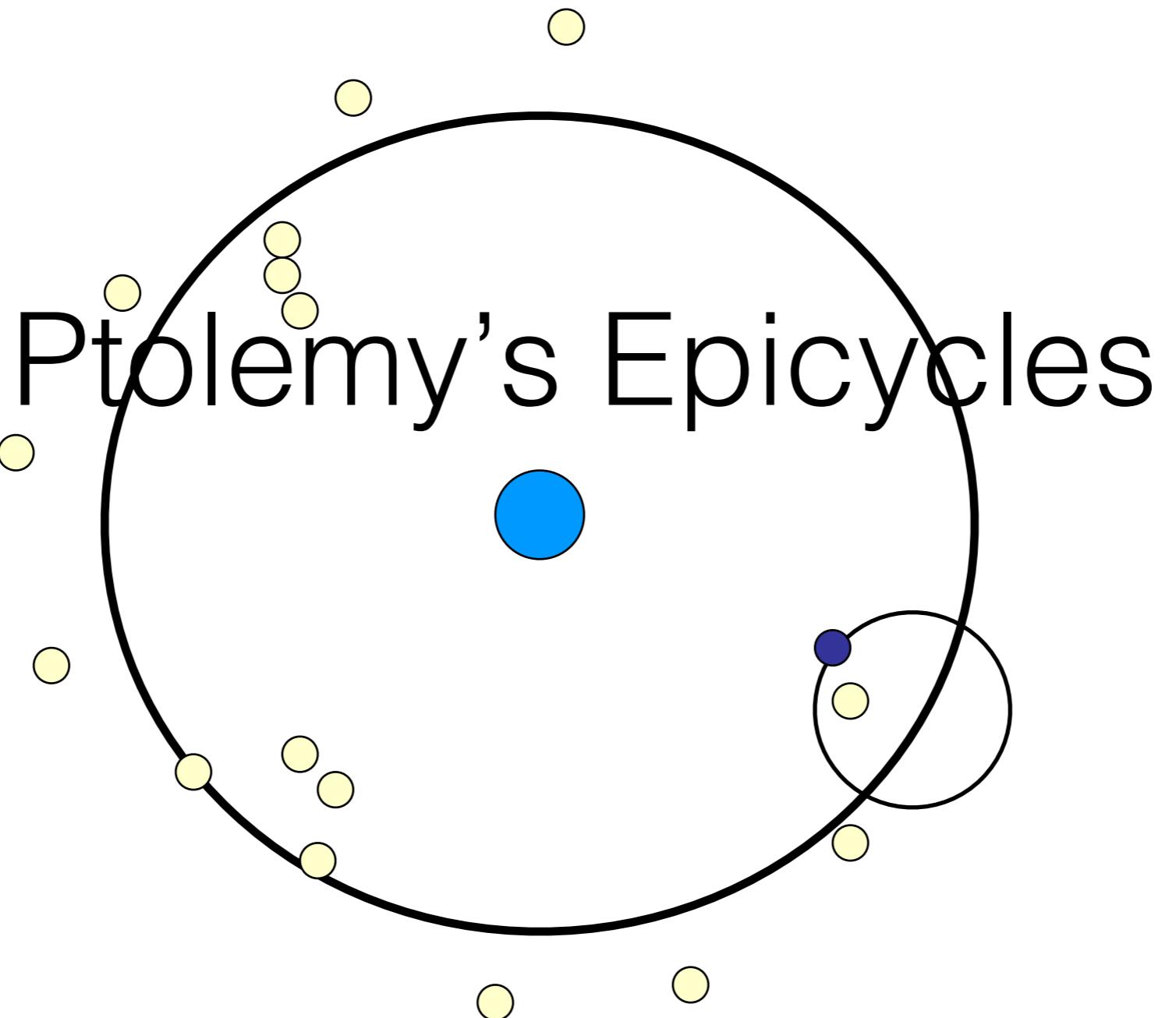
Ptolemy's Epicycles



Ptolemy's Epicycles

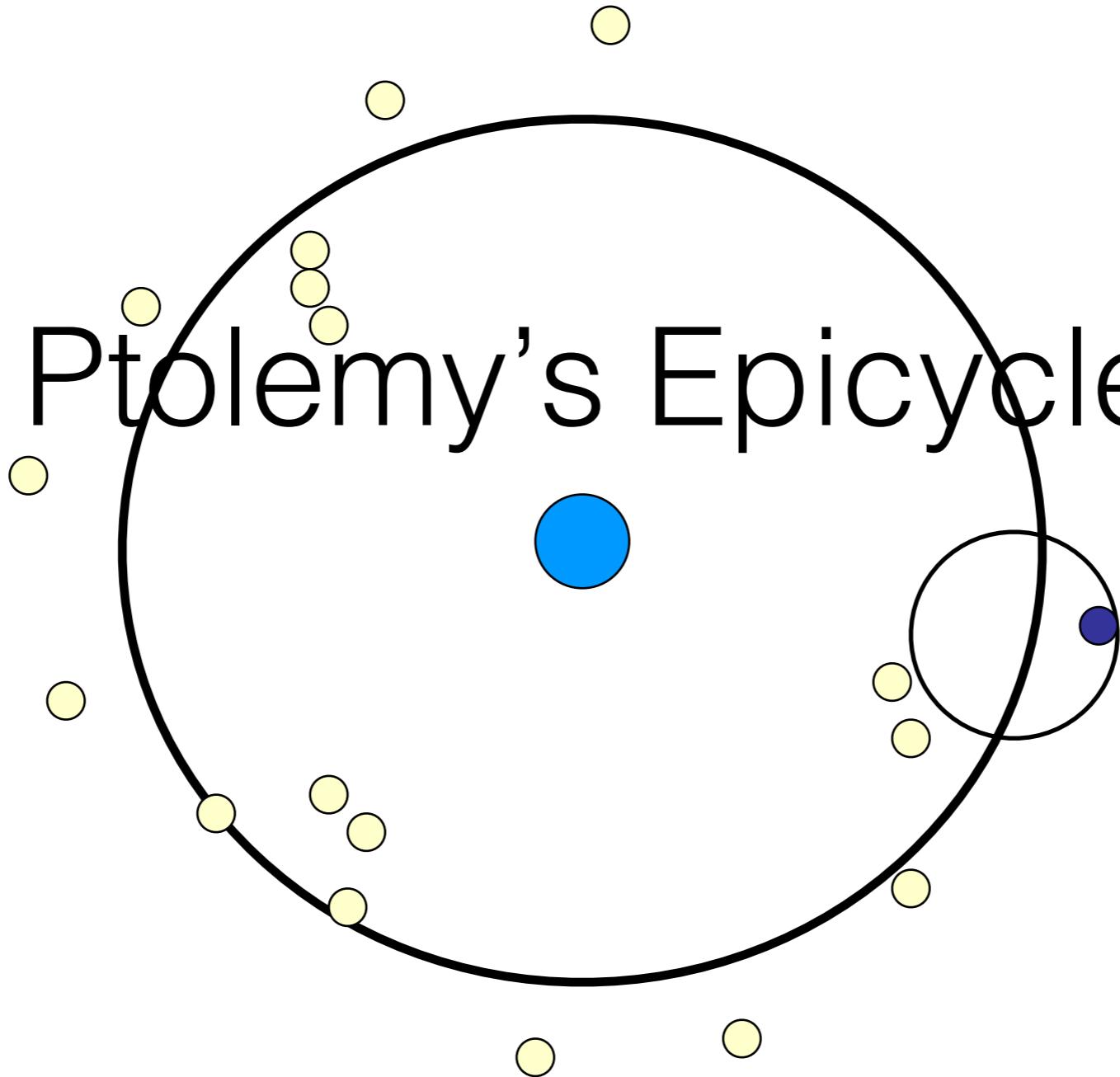


Ptolemy's Epicycles

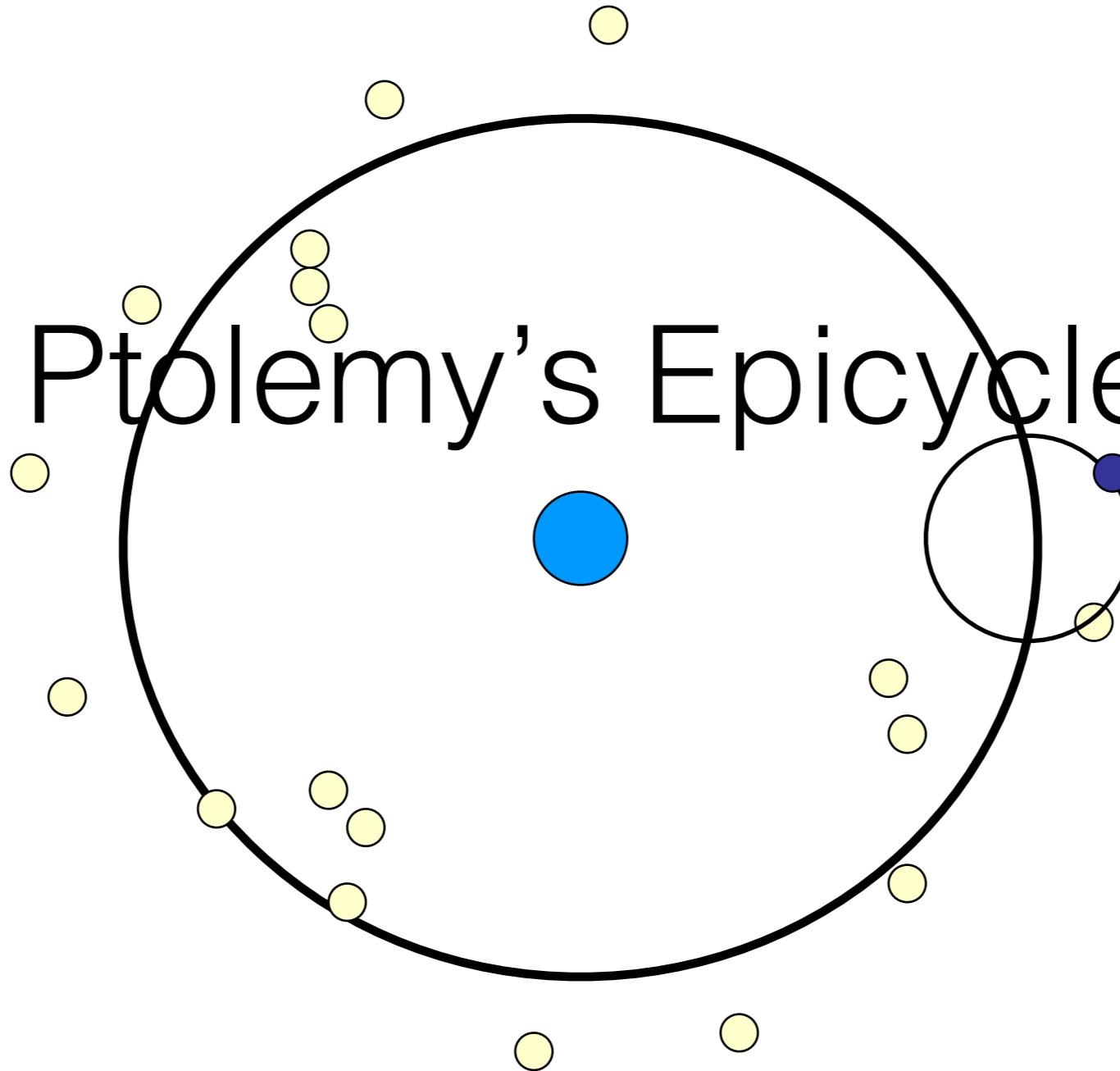


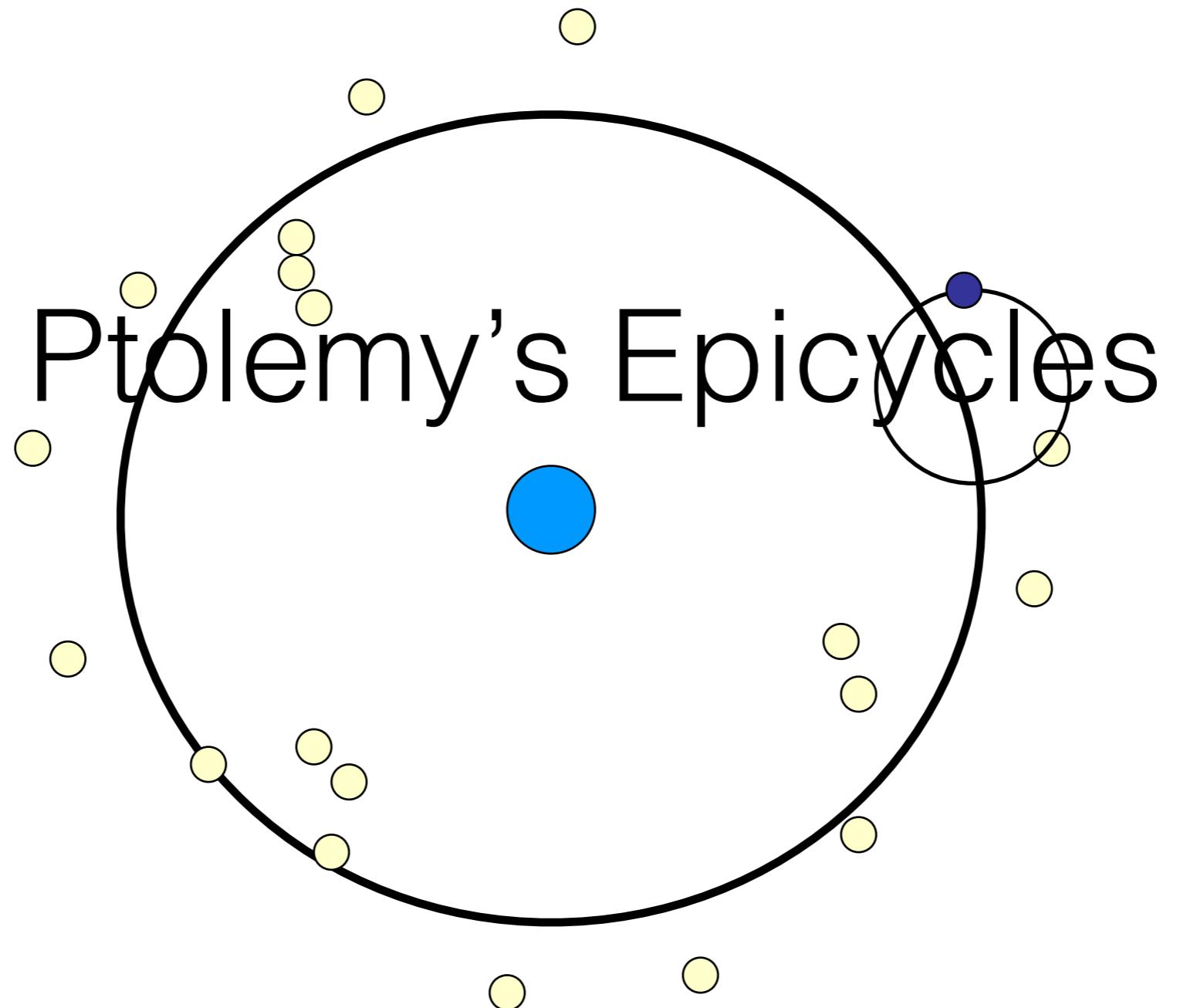
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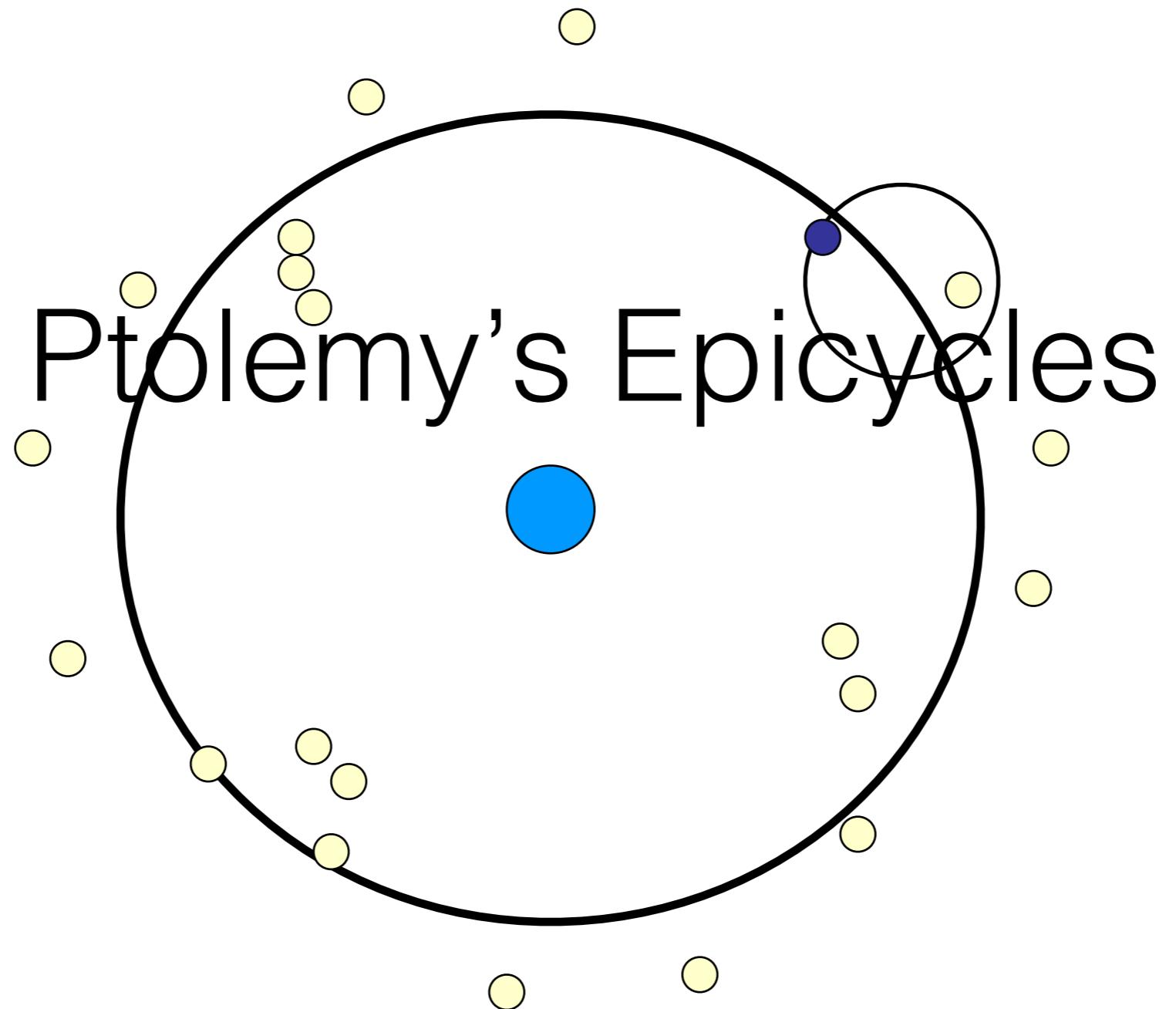
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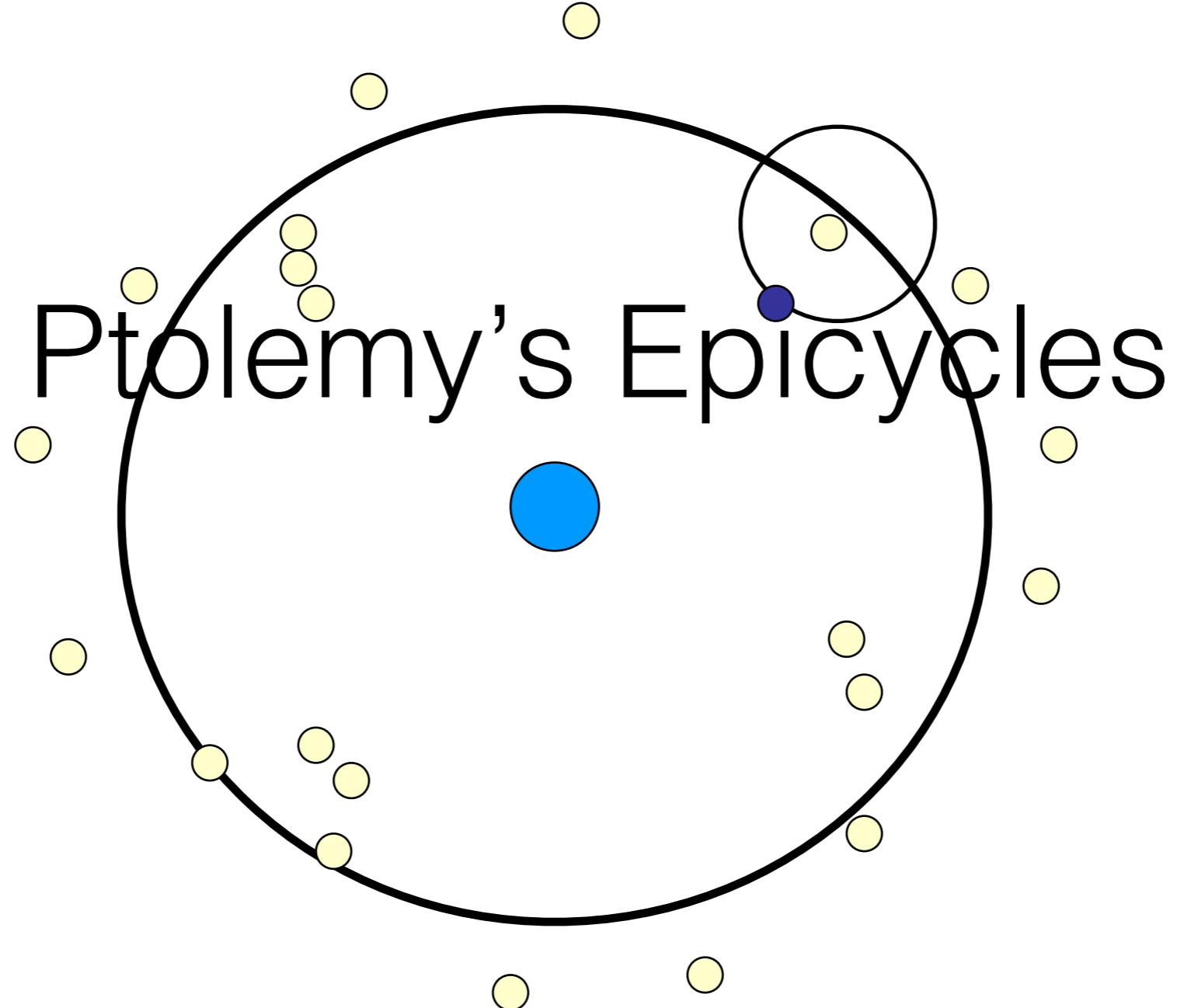


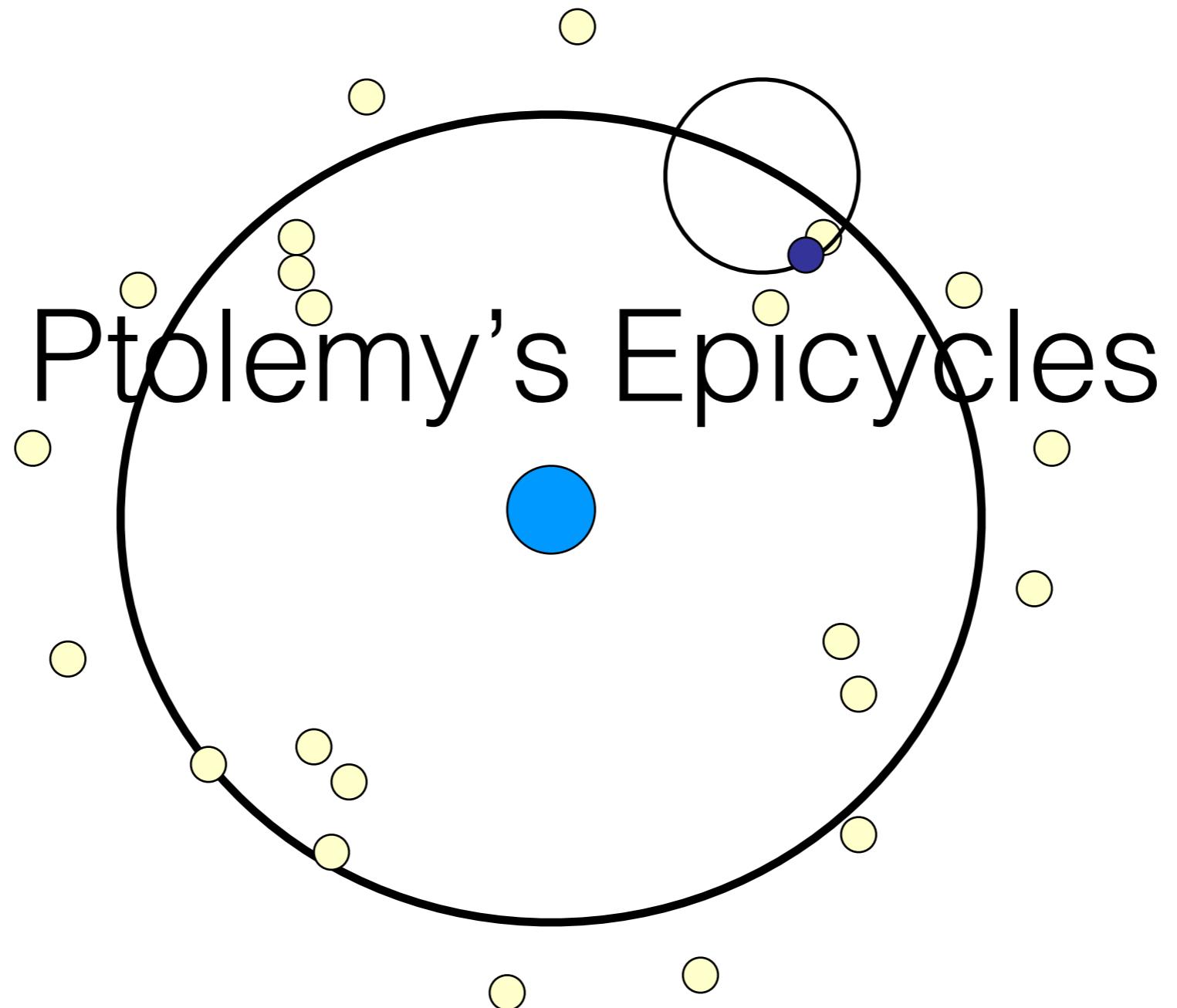
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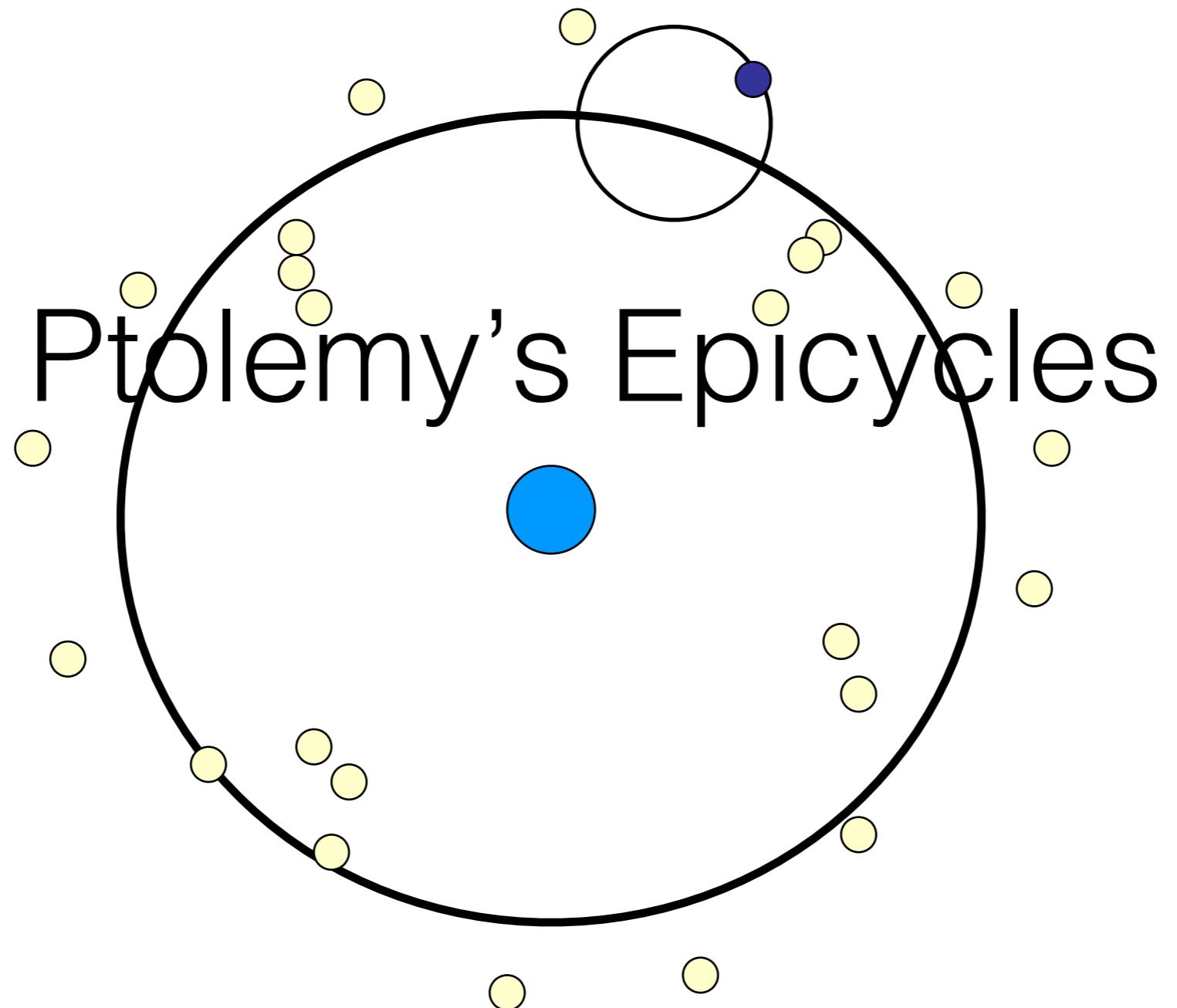






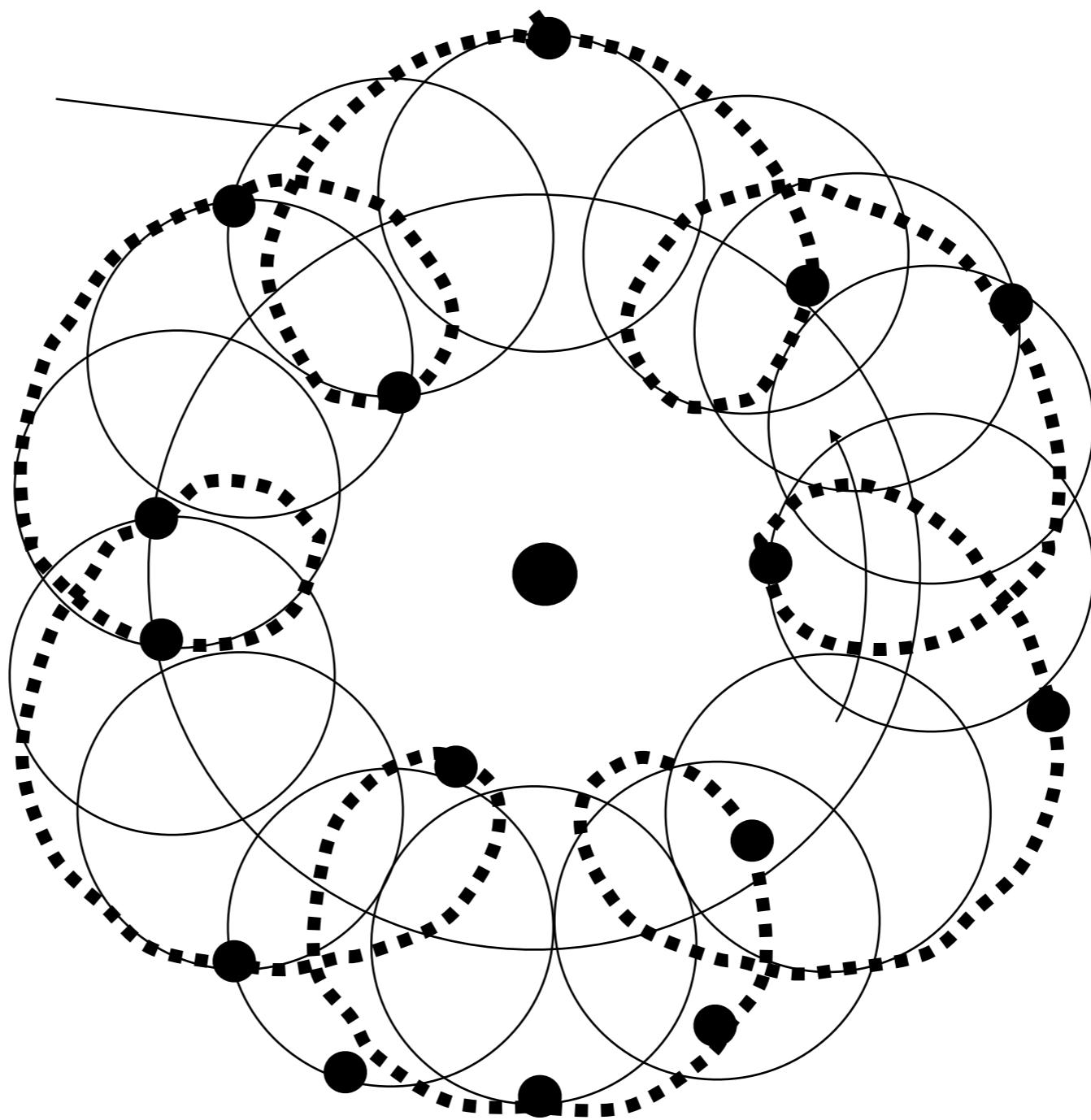






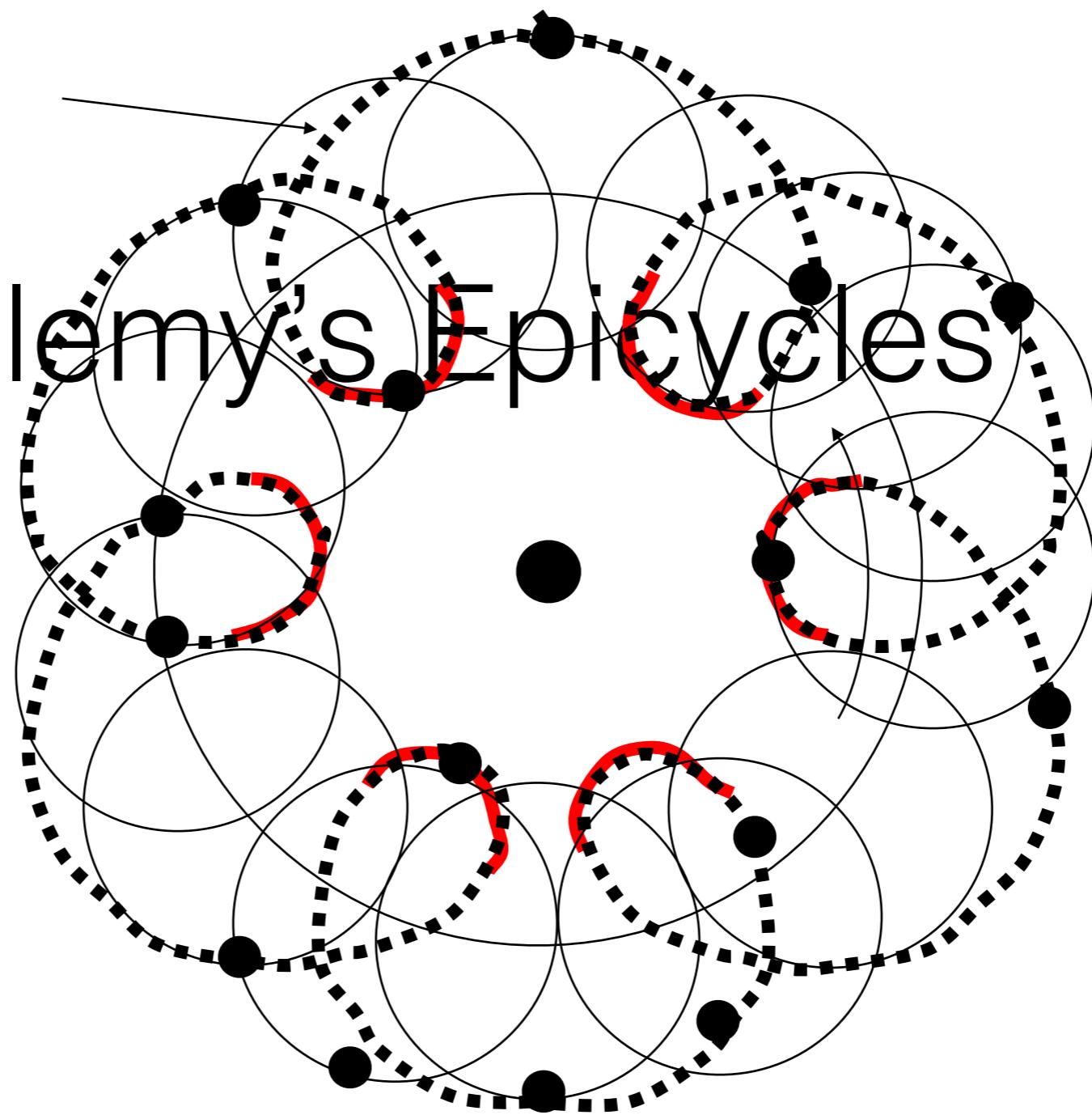
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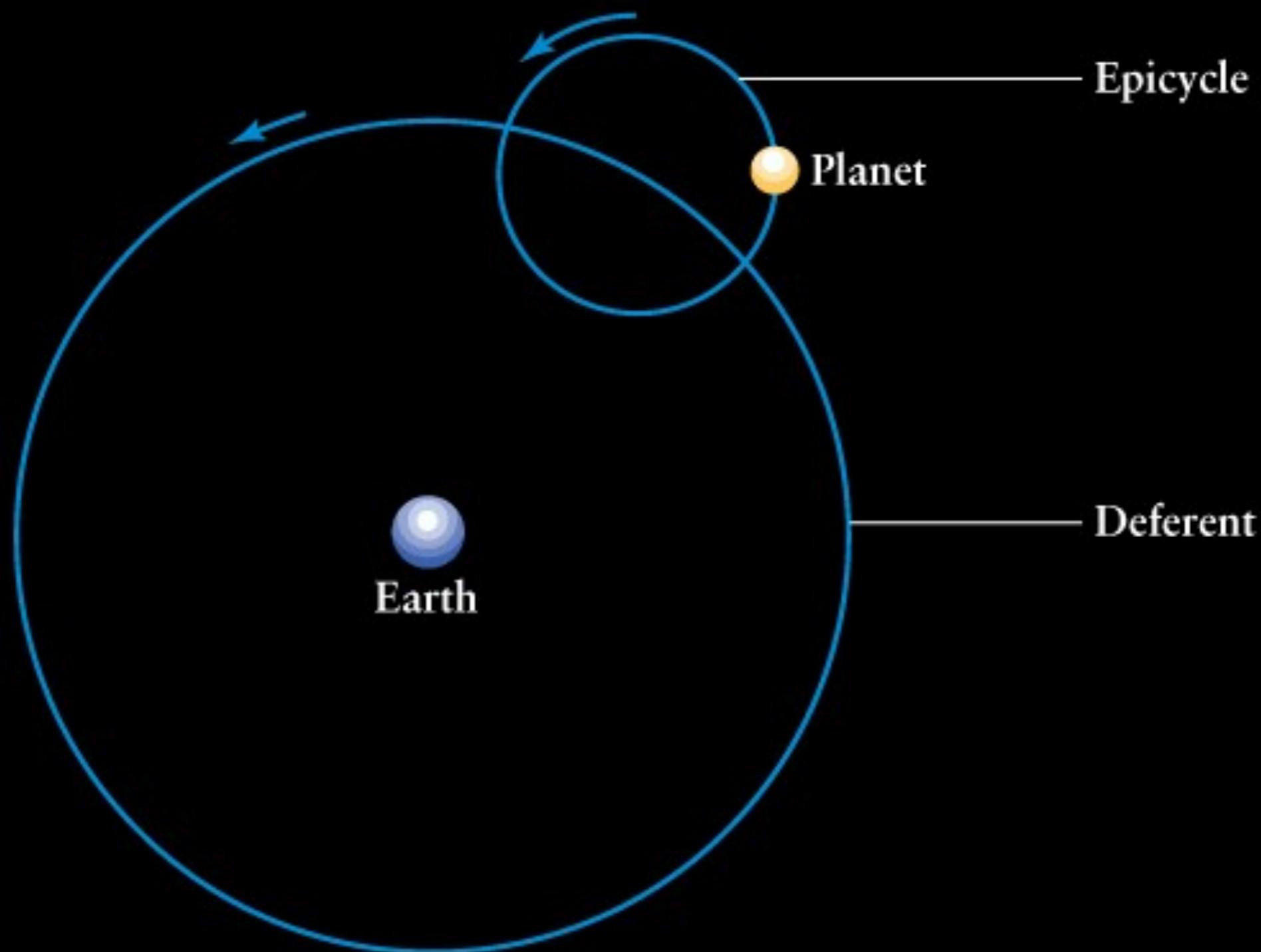
Where is retrograde motion occurring?



Where is retrograde motion?

Ptolemy's Epicycles

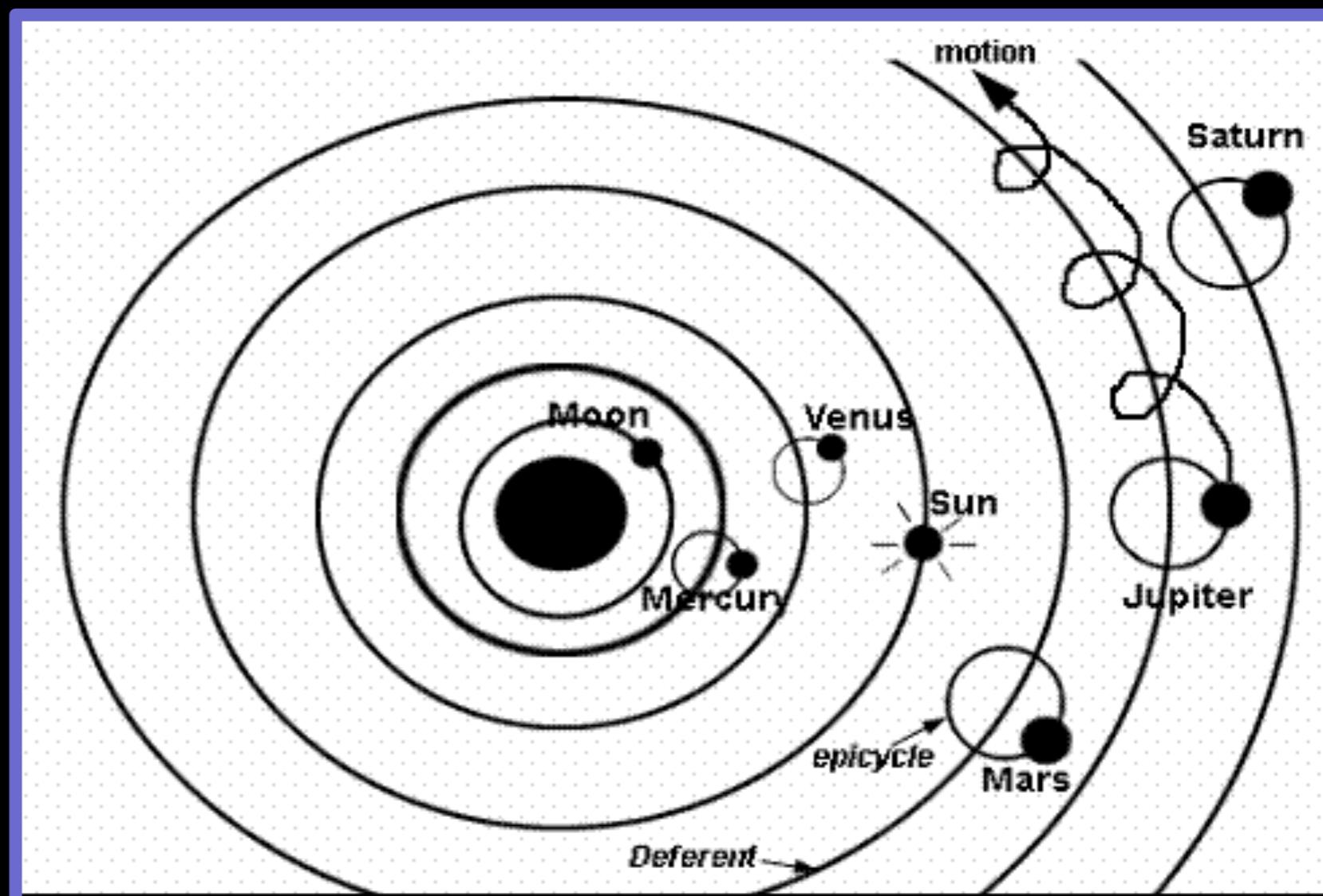




Problem - Ptolemy's model was NOT accurately predicting the position of all the planets over time.

1) Retrograde motion was hard to reproduce

2) Had to keep adding smaller epicycles to reproduce planetary motion



What to take away so far:

- 1) Many cultures have contributed to astronomical knowledge over millennia
- 2) Different cultures reached different levels of knowledge at different times
- 3) The earliest people wanted to understand the sky, their gods and when to plant crops
- 4) We know that ALL impressive monuments like Stonehenge and the pyramids were built by people not aliens