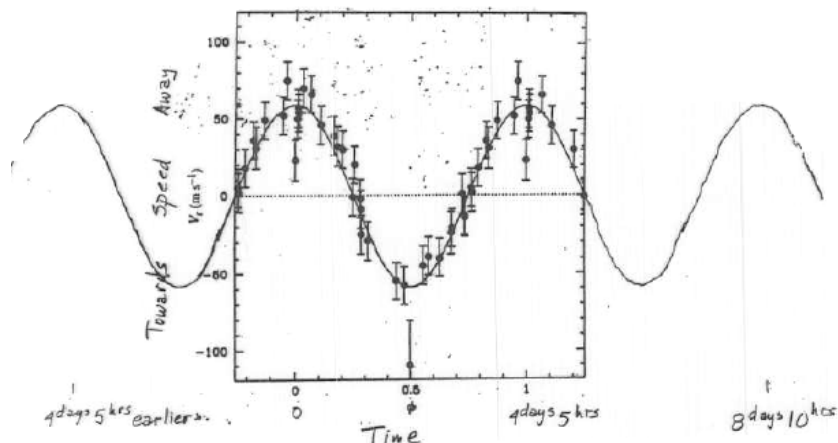


Greek Cosmology

- Finish 51 Peg
- What did Greek cosmologists study?
- Eratosthenes measures the Earth
- Homework 1
 - Due Monday, Sept 14.
 - You may work with your Ast207 buddies, but you must write your own homework. (No copies.)
 - Missouri (Show me) Club on Fri, Sept 11.
 - Homework is accessible on angel. Link is on the syllabus.

Motion of 51 Peg Away & Towards Us

- In 1994, Michel Mayor and Didier Queloz began to observe the motion of the star 51 Pegasi. They found that it moves towards us and then away from us and the towards us, etc. It repeats every 4 days and 5 hours. The fastest it moves is 60m/s or 120mi/hr, which is unusually slow for an astronomical object. (Earth moves 5000 times faster.) — Kids' College, 1998



Clues and proposed models

- | | |
|--|--|
| I. 51 Peg is in a circular orbit. | 1. The star moves away, then toward, then away, etc. The motion repeats every 4days & 5 hours. |
| II. Two planets orbit 51 Peg and pull it towards them. | 2. The fastest speed is 60m/s. |
| III. 51 Peg and a planet orbit each other around a point that is very near 51 Peg. | 3. The speed is very slow compared with the Earth's speed around the sun. |
| IV. 51 Peg orbits an unseen black hole. | |

Develop the models

- | • Original statement | • Revised statement |
|---|---|
| I. 51 Peg is in a circular orbit. | I. 51 Peg is in a circular orbit. |
| II. 51 Peg orbits an unseen black hole. | II. 51 Peg orbits an unseen object (such as a black hole, faint star, or neutron star). [51 Peg orbits an unseen black hole.] |
| III. Two planets orbit 51 Peg and pull it towards them. | III. 51 Peg and a planet orbit each other around a point that is very near 51 Peg. [Two planets orbit 51 Peg and pull it towards them.] |
| IV. 51 Peg and a planet orbit each other around a point that is very near 51 Peg. | |

Develop the models

- Revised statement
- I. 51 Peg is in a circular orbit.
- II. 51 Peg orbits an unseen object (such as a black hole, faint star, or neutron star). [51 Peg orbits an unseen black hole.]
- III. 51 Peg and a planet orbit each other around a point that is very near 51 Peg. [Two planets orbit 51 Peg and pull it towards them.]
- Revise again: II & III incorporate idea in I.
- I. 51 Peg orbits an unseen object (such as a black hole, faint star, or neutron star).
- II. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.

Develop the models

- I. 51 Peg orbits an unseen object (such as a black hole, faint star, or neutron star).
- II. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.
- 1. How would the observations differ if model I, rather than model II were true?
 - A. There is no difference.
 - B. The period would be longer.
 - C. The speed would be greater.
 - D. The shape of the curve would change, such as a faster rise and slower fall.
- To answer this, we need an analogy from our previous experience.
 - Two race cars take the same time to circle the track. The outside car moves faster.
 - Two guys on a see-saw. The pivot is near the middle. A guy & a cat on a see-saw. The pivot is near the guy.

Orbit of 51 Peg

- How big is the orbit?
- Speed is 60m/s. Period is 4day 5hr = 101 hr.
- Circumference is
 $60\text{m/s} \times (3600\text{s/hr}) \times 101\text{hr} = 22,000\text{km}$
- Circumference of Earth is 40,000km
- Sun is 100 times bigger.
- Planet causes 51 Peg to move $1/200^{\text{th}}$ of its radius.

Testing your idea Does any clue refute any part of the model?

1. Clue 1 refutes model I. Clue 1 refutes model II.
 - A. TT
 - B. TF
 - C. FT
 - D. FF
 2. Clue 2 refutes model I. Clue 2 refutes model II.
 - A. TT
 - B. TF
 - C. FT
 - D. FF
- Models:**
- I. 51 Peg orbits an unseen object (such as a black hole, faint star, or neutron star).
 - II. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.
- Clues:**
1. The star moves away, then toward, then away, etc. The motion repeats every 4days & 5 hours.
 2. The fastest speed is 60m/s.
 3. The speed is very slow compared with the Earth's speed around the sun.

Testing your idea Does any clue refute any part of the model?

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 - A. TT
 - B. TF
 - C. FT
 - D. FF
- Models:**
- I. 51 Peg orbits an unseen object (such as a black hole, faint star, or neutron star).
 - II. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.
- Clues:**
1. The star moves away, then toward, then away, etc. The motion repeats every 4days & 5 hours.
 2. The fastest speed is 60m/s.
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Mayor & Queloz discovered the first planet outside the solar system

Extrasolar planets

- Mayor & Queloz discovered an extrasolar planet.
- Q: What key clue says they discovered a planet and not a faint star?
 - a. Period is 4days 5hr.
 - b. Speed of star is 60m/s.
 - c. Motion repeats.
 - d. They did not see the companion object.

What did Greek cosmologists study (200BC-200AD)

- Cosmology is the study of the universe at the largest scales
- Erathosthenes measured the size of the earth.
- Hipparchus measured the distance to the moon.

Erathosthenes measures size of Earth ~200 BC

- A correspondent in Syene reports that at noon on the summer solstice, the sun illuminates the bottom of a well. In Alexandria (where Erathosthenes lived), a stick makes a 7° shadow.
- It takes a camel 50 days to travel from Syene to Alexandria. A camel can travel 100 stadia/day.
- What is the distance between Alexandria & Syene in km?

Erathosthenes ~200 BC

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- It takes a camel 50 days to travel from Syene to Alexandria. A camel can travel 100 stadia/day.
- 1. What is the distance between Alexandria & Syene in km?
What is the length of a stadium?
- Guess that a stadium is 100m.
- What is the distance between Alexandria & Syene in km?
 - $100\text{m/stadium} \times 100\text{stadia/day} \times 50\text{days} = 500,000\text{m} = 500\text{km}$

Erathosthenes ~200 BC

- A correspondent in Syene reports that at noon on the summer solstice, the sun illuminates the bottom of a well. In Alexandria (where Erathosthenes lived), a stick makes a 7° shadow.
- It takes a camel 50 days to travel from Syene to Alexandria. A camel can travel 100 stadia/day.
- 1. The distance between Alexandria & Syene is 500 km?
- 2. Draw a picture to show the relationship between the sun, the well, the stick, and the two locations. "A clear picture is 90% of clear thinking."
- Picture shows Alexandria & Syene are 7° apart in latitude.
- The circumference is 360° around Earth
 - $500\text{km} \times 360^\circ/7^\circ = 25,000\text{km}$
- Actual circumference is 40,000km.