# 51 Pegasi—3 Sept

- Course goals
  - to generate and evaluate scientific evidence and explanations
  - to understand the nature and development of scientific knowledge
  - to participate productively in scientific practices and discourse
- Michael Mayor & Didler Queloz discovered something important by studying the star 51 Pegasi.
- The steps to discovery
  1. Examine the data for the facts. What is the evidence? Collect clues. <u>Done</u>.
  2. Brainstorming. What are models that explain the evidence? <u>Done</u>
  3. Developing your idea
  4. Testing your idea Does any clue refute any part of the model?
  5. What was discovered?

- Homework 1
  - Due Friday, Sept 10.
  - You may work with your Ast207 buddies, but you must write your own homework. (No copies.)
  - Missouri (Show me) Club on Wed, Sept 8.
  - Homework is accessible on angel. Link is on the syllabus.

Motion of 51 Peg Away & Towards Us

- In 1994, Michel Mayor and Didler 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.) — MSU Kids' College, 1998
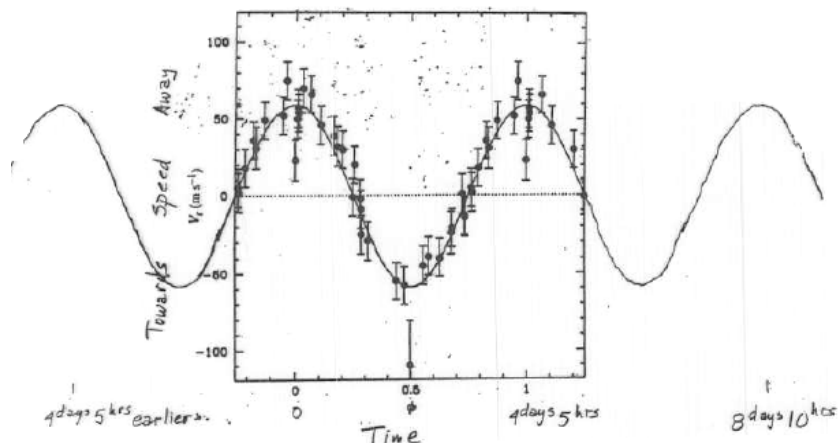
Clues and proposed models

Clues

1. The star moves away, then toward, then away, etc. The motion repeats every 4days & 5 hours.
2. The speed away and speed towards match.
3. The fastest speed is 60m/s.
4. The speed is very slow compared with the Earth's speed around the sun (30km/s).

Models

I. 51 Peg is in a circular orbit.
II. 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.
IV. 51 Peg orbits an unseen black hole.

Develop the models

Models

I. 51 Peg is in a circular orbit.
II. Two planets orbit 51 Peg and pull it towards them.
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IV. 51 Peg orbits an unseen black hole.

Revised Models

I. 51 Peg is in a circular orbit.
II. Two planets orbit 51 Peg and pull it towards them. [Eliminate for now; analyze the case of one planet.]
III. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.
IV. 51 Peg orbits an unseen object with a stellar mass (such as a black hole, faint star, or neutron star).

Develop the models

Revised Models

I. 51 Peg is in a circular orbit.

II. Two planets orbit 51 Peg and pull it towards them. [Eliminate for now; analyze the case of one planet.]

III. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.

IV. 51 Peg orbits an unseen object with a stellar mass (such as a black hole, faint star, or neutron star).

Revised 2nd time

Assume circular orbits for both models.

I. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.

II. 51 Peg orbits an unseen object with a stellar mass (such as a black hole, faint star, or neutron star).

Develop the models

I. 51 Peg and a planet orbit each other around a point that is very near 51 Peg.

II. 51 Peg orbits an unseen object with a stellar mass (such as a black hole, faint star, or neutron star).

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
  60m/s*(3600s/hr)*101hr=22,000km
- Circumference of Earth is 40,000km
- Sun is 100 times bigger.
- Planet causes 51 Peg to move in a circle that is
  $1/200^{th}$ of its circumference.

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 with a stellar mass (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?

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.

Mayor & Queloz discovered the first planet outside the solar system

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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.