Lecture 4

Wednesday: Read 1.4 - 1.5

Group Exercise!

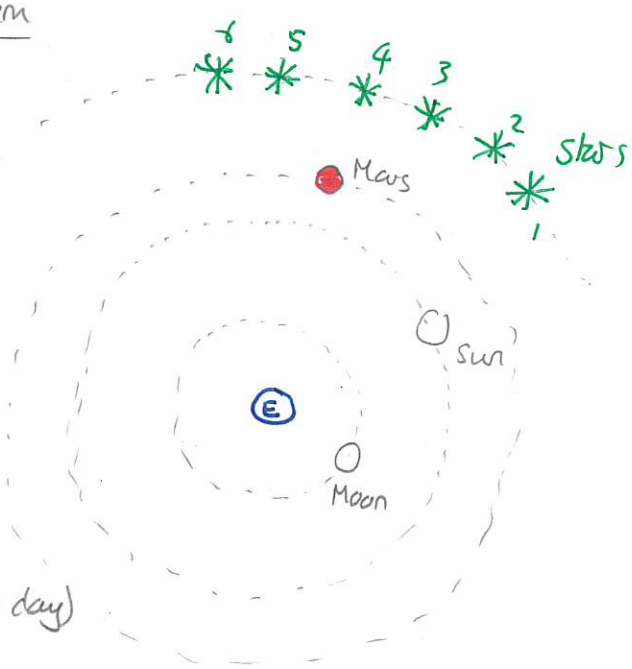
Friday: *HW by 5pm

- HW help → My office hrs
  → Tutoring Center.

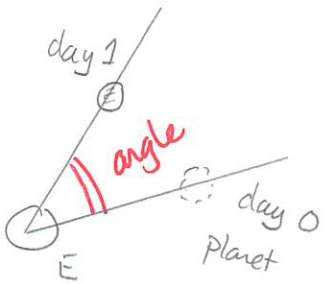
Simple geocentric model of the solar system

A simple geocentric model has:

1) Earth is fixed (stationary) at the center of solar system
2) Sun, Moon and all planets orbit in circular paths
3) Each planet has its own orbital radius and orbits at a fixed angular rate (angle per hour or per day)
4) The stars are furthest away and fixed relative to each other. They orbit at different angular rates to the planets.



We should clarify angular rates. This is the apparent angle traced out in a period of time



Slide: Angular rate

Quiz 1 80% - 106%

Quiz 2 80% -

The simple geocentric model predicts:

> Any single planet appears to move against the stars and the direction of motion is always the same.

We need to check against observations. These show that there are periods when the planet appears to reverse direction. This is

> Retrograde motion ~ the apparent direction of motion of the planet when viewed from Earth reverses

DEMO: APOD * Mars Image
* Saturn Image click to play

Thus

Geocentric model predicts – constant direction of motion

Observations – direction sometimes reverses

→ Geocentric model is incorrect.

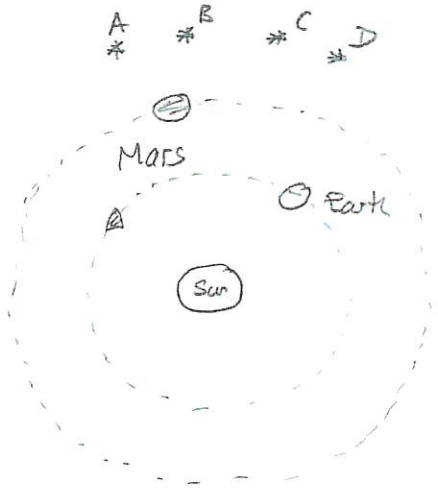
The contradiction was resolved by ancient Greeks, eventually giving a complicated model due to Ptolemy (AD 100–170)

DEMO: Thurston video
Foothills animation

Heliocentric models of the solar system

By the early 1500s simpler alternative models of the solar system, in which the planets orbited the Sun, emerged. These are heliocentric models. The simplest, due to Copernicus (in 1543), has these components:

1) Sun is fixed at the center of the Solar System
2) Stars are fixed and very distant
3) Each planet orbits in a circle around Sun
4) Earth rotates about its own axis



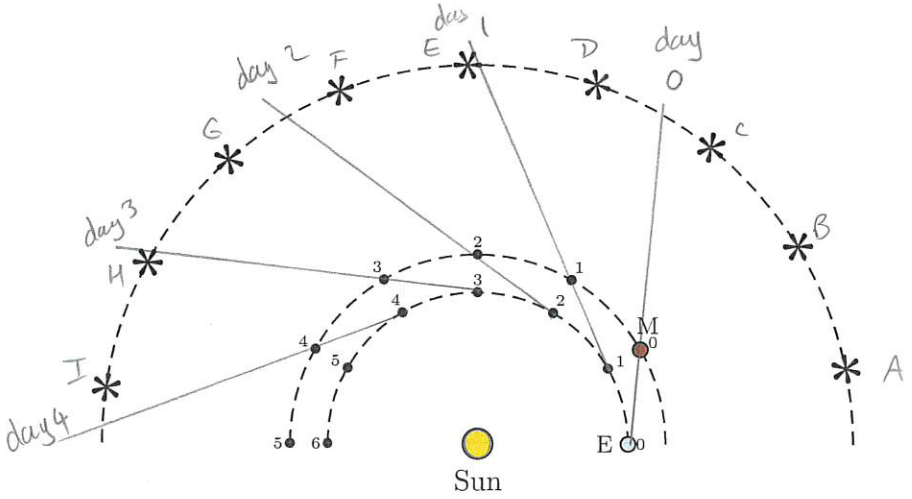
DEMO: Either - 2-D Solar system EduMedia
- The Sky 3-D

We now consider predictions based on two possibilities

1) all planets orbit at the same rate (1 yr to complete orbit)
2) planets orbit at different rates.

1 Heliocentric model predictions: same rates

Consider Mars (labeled M) in a heliocentric model. The stars (labeled ~~1,2,3,...~~) are arranged as illustrated. Assume that Earth and Mars orbit counterclockwise along each of the illustrated circular trajectories. One can observe the apparent position of Mars against the background stars when viewed from Earth. Assume that Earth and Mars orbit at *the same angular rate*. As the months pass, the positions of Earth and Mars are illustrated (e.g. they are at "1" after the first month, "2" after the second month, etc.)



a) When viewed from Earth, how does the position of Mars appear to change against the background stars? Does it appear to move in the same direction or not? Explain your answer, preferably with a diagram that you draw accurately.

b) Can this model explain the observed retrograde motion of Mars?

Lines of sight =>

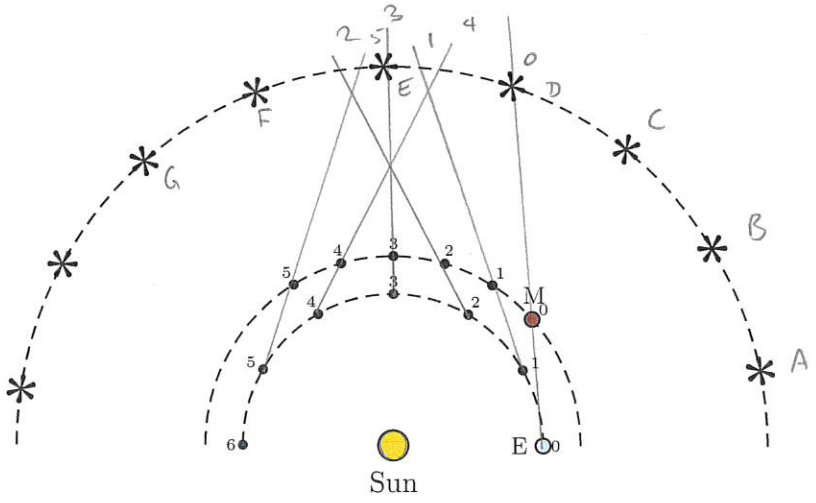
a) The diagram shows it moves in one direction

C -> D -> E -> F -> G -> H

b) No, it always appears to move in one direction

2 Heliocentric model predictions: different rates

Consider Mars (labeled M) in a heliocentric model. The stars (~~labeled 1,2,3,...~~) are arranged as illustrated. Assume that Earth and Mars orbit counterclockwise along each of the illustrated circular trajectories. One can observe the apparent position of Mars against the background stars when viewed from Earth. Assume that Earth and Mars orbit at *different angular rates*. As the months pass, the positions of Earth and Mars are illustrated (e.g. they are at "1" after the first month, "2" after the second month, etc.)



a) When viewed from Earth, how does the position of Mars appear to change against the background stars? Does it appear to move in the same direction or not? Explain your answer, preferably with a diagram that you draw accurately.

b) Can this model explain the observed retrograde motion of Mars?

a) Position does change

Between months 2 → 4 it appears to reverse going ↷

The rest of the time it appears to go ↶

b) Yes

Slides: Show all slides

Demo: UNM Retrograde Animation

We see then that

> The heliocentric model where planets orbit at different rates does predict that for any planet there will be periods of apparent retrograde motion.

In this sense the heliocentric model is better than the simple geocentric model. However, the model needs further details

1) radius of circular orbits
2) rates of orbits

These need to be used to predict motion and those again need to be checked against more detailed observations.