Announcements

- New WebWorK posted. Will be due on *Wednesday* at 10am
- No class on Monday!
- No lab next week!
- Poll: `rembold-class.ddns.net`

Back to APOD

Review Question

On the celestial sphere, the latitude (declination) of the star Vega is list as $38°47'7''$. What decimal angle does this correspond to?

A. $3.318°$
B. $38.477°$
C. $38.477\,\text{h}$
D. $38.785°$

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Celesial Sphere Demonstrations

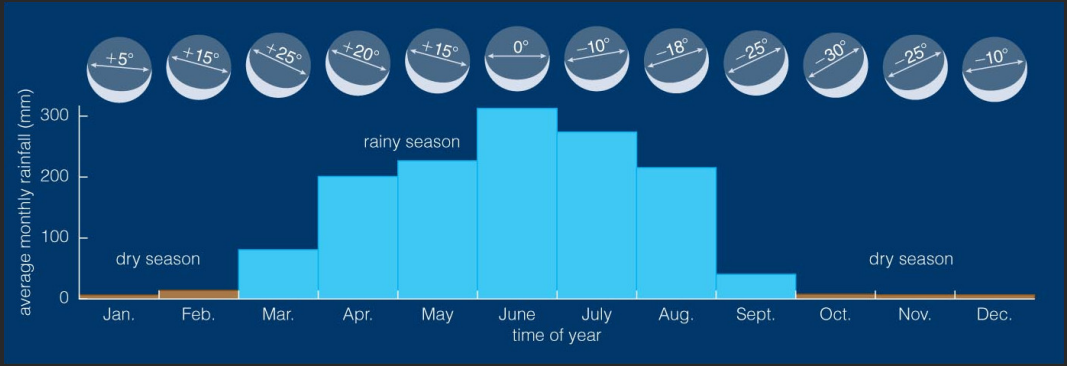
Example

- How long is the sun up today here on the 45th parallel?
- How long is the sun up today up in Alaska on the 65th parallel?
- How high will the sun rise in the sky for us on December 10th?
- What time will Orion rise on October 31?
- What altitude and azimuth will Vega have at midnight tonight?

A Historical Perspective on Science

- Scientific reasoning is based on using ideas of observation and trial-and-error to inform and gain understanding
- Astronomy is among the oldest of the sciences
- Generally used for very practical purposes
  - Tracking time and the seasons
    - Agricultural purposes
    - Religious purposes
  - Aiding in Navigation

Ancient Astronomic Uses



The ancient people of central Africa (6500 BC) could predict rainy seasons from the orientation of the Moon.

Modern Holdovers

The days of the week are named after the major 7 visible heavenly objects visible to the ancients!

Object	English	French	Spanish
Sun	Sunday	Dimanche	Domingo
Moon	Monday	Lundi	Lunes
Mars	Tuesday	Mardi	Martes
Mercury	Wednesday	Mercredi	Miércoles
Jupiter	Thursday	Jeudi	Jueves
Venus	Friday	Vendredi	Viernes
Saturn	Saturday	Samedi	Sábado

Astronomic Achievements of the Ancients

- Daily Timekeeping

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Astronomic Achievements of the Ancients

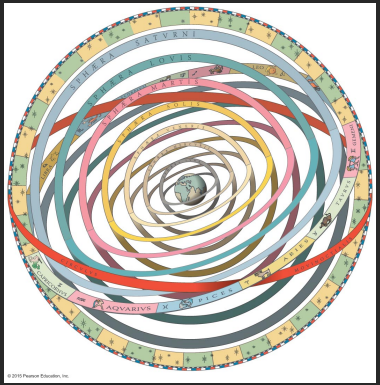
- Daily Timekeeping
- Tracking the seasons
- Monitoring lunar cycles
- Monitoring planets and stars
- Predicting eclipses

Tis all Greek

- Ancient Greece located at a crossroads for the exchange of knowledge
  - Much of our math and science heritage heralds from the Middle East.

The Essence of Modern Science

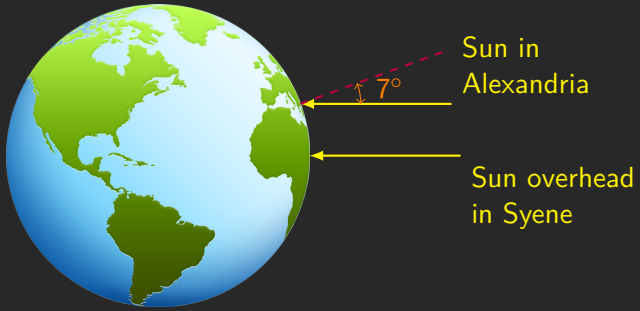
- Ancient Greeks were the first known people to make models of nature.
- Tried to explain patterns in nature without resorting to myth or spiritual
- Explanations had to agree with observations



Greek interpretation of the geocentric model of the solar system

Eratosthenes

The first accurate estimate of the Earth's circumference



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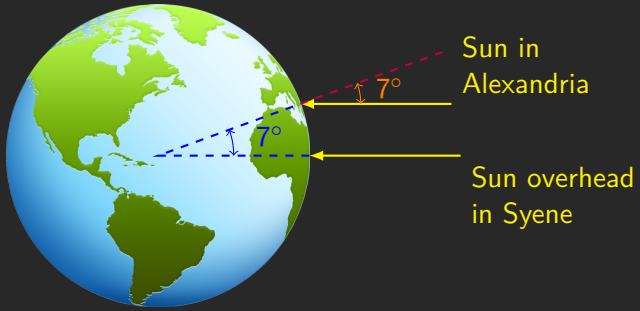


Eratosthenes Work

- Straight line distance between Syene and Alexandria $\approx 5000\,\text{stadia}$
- Can set up a proportion between angular and measured distances

$$\frac{\text{Part}}{\text{Whole}} = \frac{7^\circ}{360^\circ} = \frac{5000\,\text{stadia}}{\text{Circumference}}$$

- So the circumference equaled:

$$\text{Circumference} = 257\,143\,\text{stadia}$$

- One stadia is approximately $0.167\,\text{km}$, so:

$$\text{Circumference} = 42\,857\,\text{km}$$

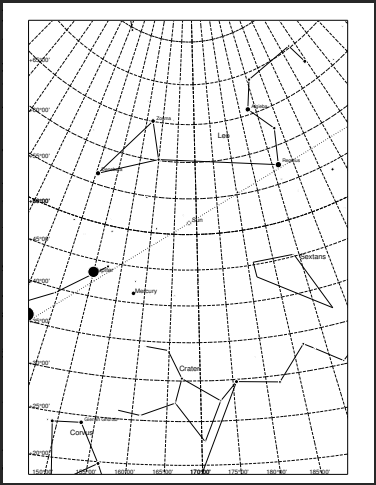
- This is remarkably close to the actual value of $40\,075\,\text{km}$!

Putting it to Practice

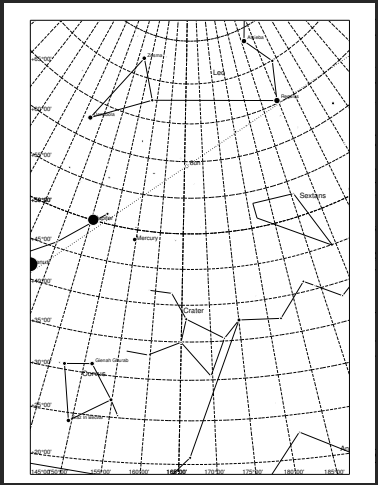
Example

Imagine you and a fellow astronaut found yourself stranded on a strange planet. You synchronize your watches, and then he or she walks approximately 500 km due South. Then, at the same time, you both take pictures of the sky before meeting back up to compare. Given your images and how far your friend traveled, what planet are you likely on?

Your Images



Your image



Your friend's image

Your Calculations

- The sun is out, so you probably can't see the stars, but you could have chosen any point to measure from
- The angular separation seems to be about 8°

$$\frac{8^\circ}{360^\circ} = \frac{500\,\text{km}}{\text{Circumference}}$$

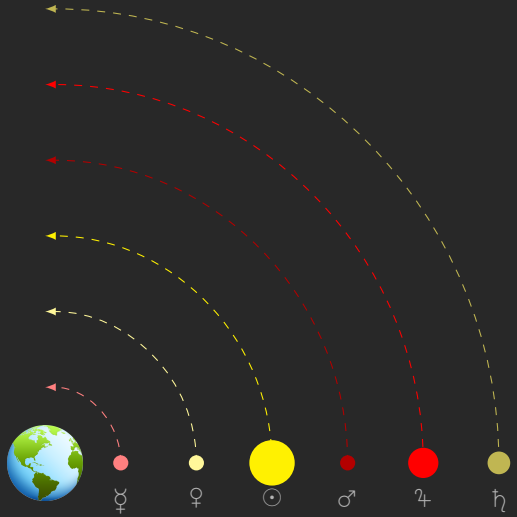
- Thus the planets circumference is approximately 22 500 km
- Corresponds to a radius of approximately 3600 km
- Checking a table, it would seem you are most likely on Mars!

A Starry Backdrop

- Because stars are so far away, any movement they have is too small to be seen, thus they appear fixed
- Closer objects (like planets) do have large enough movements to be seen
- Easiest to measure these visible movements against the “fixed” starry backdrop
- One of the earliest methods of tracking planets

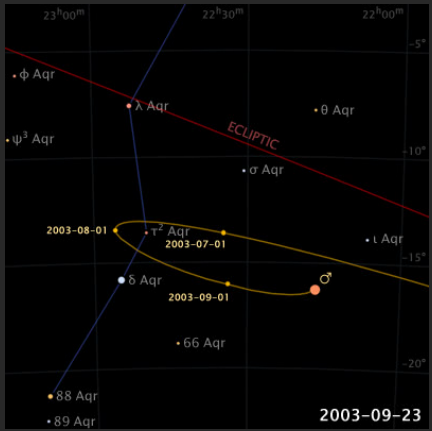
Mars' Movement

The Geocentric Model

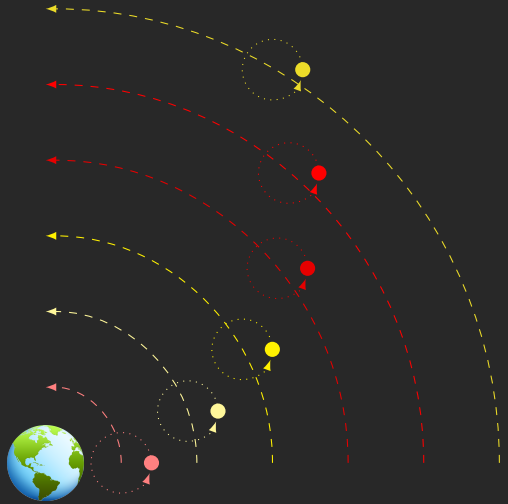


The Main Complication

- Retrograde Motion
  - For parts of the year planets move backwards relative to their normal paths
  - More obvious for some planets than others
  - This posed a major hurtle in trying to explain the motion of the planets



A Corrected Geocentric Model: Ptolemy



The Ptolemaic Model ($\approx$ 150 AD)

- The basic Aristotle idea of the geocentric model is very simple
- In practice though, the Ptolemaic model is actually extremely complex
  - Some circles larger than others
  - Some circles slightly rotating off-center
- It DID, however, quite accurately predict the observed motion of the planets

Enter Copernicus (1473-1543)

- Found that the planetary motion tables based on Ptolemaic model were growing more inaccurate
- Disliked the complexity of Ptolemaic model on aesthetic grounds
- Adopted a heliocentric model with the Sun at the center
  - Naturally explains retrograde motion
  - Naturally explained Mercury and Venus never being a large angle from the Sun
- The Heliocentric model was not significantly more accurate than the Ptolemaic model at the time.

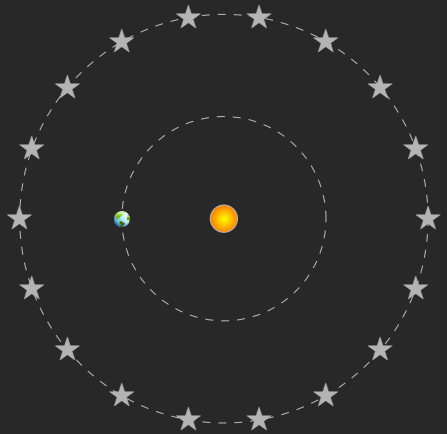
Objection! The Church

There is talk of a new astrologer who wants to prove that the earth moves and goes around, instead of the sky, the sun, the moon, just as if somebody were moving in a carriage or ship might hold that he was sitting still and at rest while the earth and the trees walked and moved. But that is how things are nowadays: when a man wishes to be clever he must needs invent something special, and the way he does it must needs be the best! The fool wants to turn the whole art of astronomy upside-down. However, as Holy Scripture tells us, so did Joshua bid the sun to stand still and not the earth.

-Martin Luther

Objection! Science

- Why aren't we dizzy?
- Why are we the only planet with a moon?
- Why don't we see stellar parallax?



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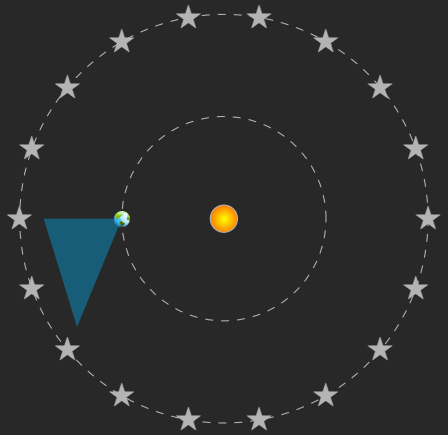

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