The Birth of Astronomy

Full moon over Cape Sounio

Photo by Anthony Ayiomitas

This is Ephesus

Picture by Tunc Tezel

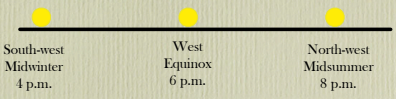
The first observatory (or the earliest we know about)

- Midsummer day: when the sun rises/sets in most northerly position.

Measured at Stonehenge: important to define seasons and hence time to plant crops

Probably 2300 BC ± 100 years

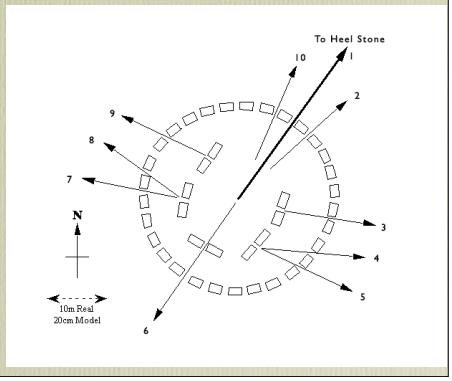
Sunset



- Note that position varies more as you move away from the equator

- Alignments let you measure summer solstice

1. Midsummer sunrise
2. Winter moonrise low point
3. Midwinter Sunrise
4. Southern moonrise (minimum)
5. Southern moonrise (maximum)
6. Midwinter sunset
7. Northern moonset (minimum)
8. Northern moonset (maximum)
9. Winter moonrise high point



http://www.fas.harvard.edu/~scidemos/AstronomyAstrophysics/Stonehenge/Stonehenge.html

Babylon: Mul Apin tablet

http://www.mesopotamia.co.uk/astronomer/explore/exp_set.html

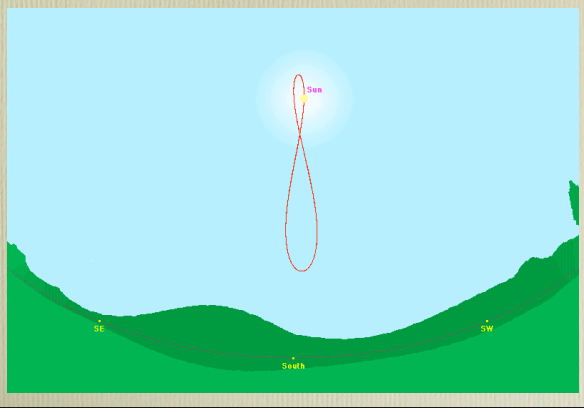
On the 1st of Nisannu the Hired Man becomes visible.

- On the 20th of Nisannu the Crook becomes visible.
- On the 1st of Ayyaru the Stars become visible.
- On the 20th of Ayyaru the Jaw of the Bull becomes visible.
- On the 10th of Simanu the True Shepherd of Anu and the Great Twins become visible.
- On the 5th of Du'uzu the Little Twins and the Crab become visible.
- On the 15th of Du'uzu the Arrow, the Snake, and the Lion become visble; 4 minas is a daytime watch, 2 minas is a nighttime watch.
- On the 5th of Abu the Bow and the King become visible.
- On the 1st of Ululu [. . . .]
- On the 10th of Ululu the star of Eridu and the Raven become visible.
- On the 15th of Ululu Shu-pa, Enlil, becomes visible.
- On the 25th of Ululu the Furrow becomes visible

Sundials

- Good to few minutes but
- ...Position of the noon sun in the sky varies throughout the year:
- It moves against the fixed stars because
- the earth orbits the sun
- the earths axis is tilted

- it also moves in the sky at a given time of day: (i.e. the time of noon varies by about 8 minutes) because the earth moves at varying speeds in its orbit,
- so we actually need a **better** clock than the sun to measure this



A tutulemma. Photo from Side, by Tunc Tezel

Combines sun's position through year with an eclipse

Eclipses

Tablet with a list of eclipses between 518 BC and 465 BC, mentioning the death of king Xerxes.

British Museum, London

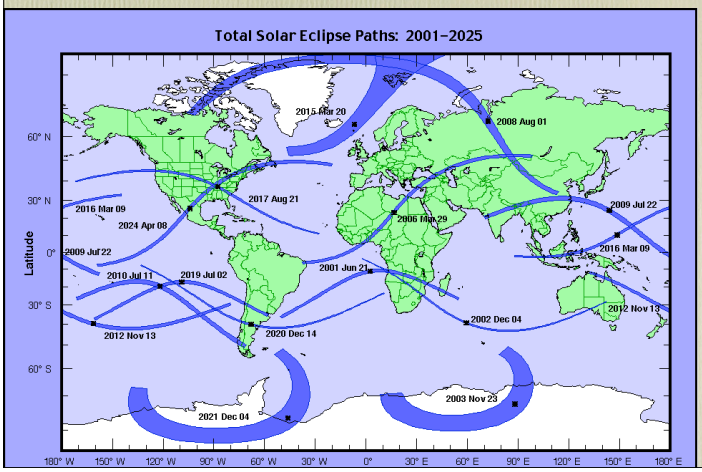
Why do these matter?

CALPURNIA: When beggars die, there are no comets seen;

The heavens themselves blaze forth the death of princes. *Julius Caesar*

(Chinese astronomers Hi and Ho executed for failing to predict eclipse in 2134 BC).

Eclipse prediction



Saros cycle

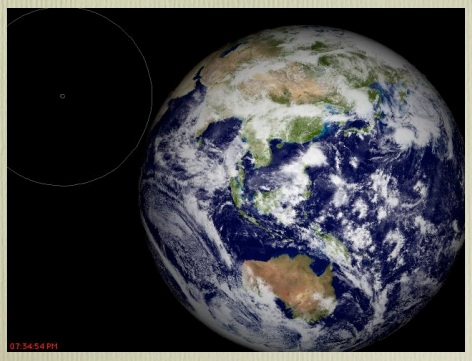
- Eclipses repeat after 18 years and 11.3 days.
- The .3 days shifts the eclipse about 110º degrees west.
- Also some saros sequences start at the south and drift North, others at the North and drift South.
- This means that the cycle is very complex: can only see it after many years.
- Why is it so complicated? Need to combine
  - I. Earths rotation
  - II. Moons orbit (not quite circular)
  - III. Earth's orbit (ditto)
  - IV. and the plane of the moons orbit precesses

And they even mattered to artists

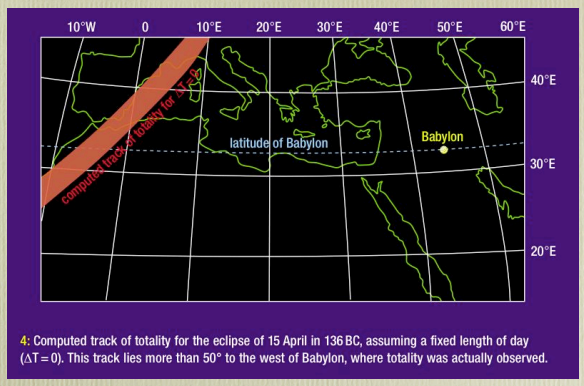
Eclipse of 1999 seen from Mir

Observed total Eclipse 15 April 136 BC.

and they would even have seen it from the moon !



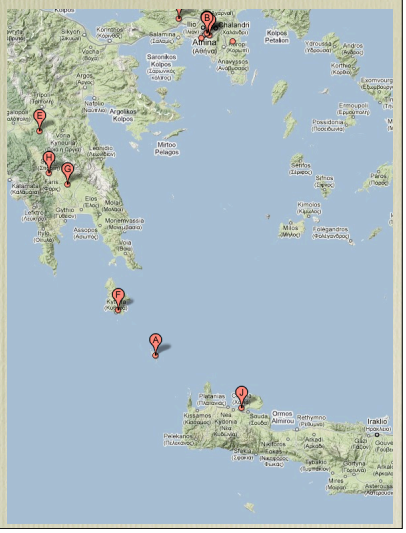
But they shouldn't have!



4: Computed track of totality for the eclipse of 15 April in 136 BC, assuming a fixed length of day ($\Delta T = 0$). This track lies more than 50° to the west of Babylon, where totality was actually observed.

- Earth's rotation has slowed down, by ~0.01 sec/century, because of tidal effects! i.e. earth isn't a very good time-keeper

Antikythera

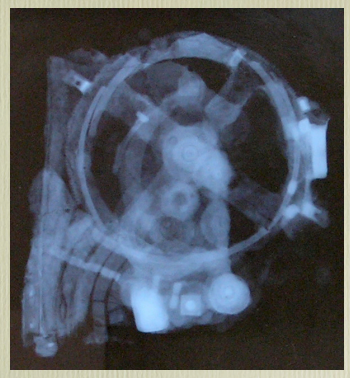


- Wreck full of sculptures

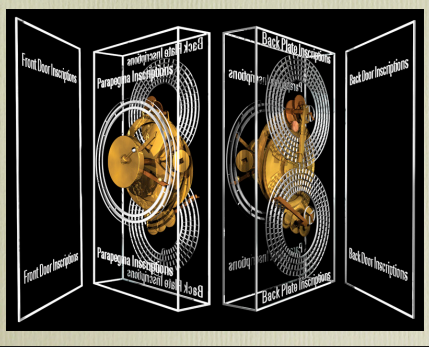
Antikythera Mechanism

- An extraordinary discovery from 1901: probably from late second century BC.
- National Archaeological Museum in Athens: wikipedia
- So what is it?

- X-rays show very complex structure



- Appears to be a very sophisticated astronomical computer:
- Includes Hipparchos' discovery of irregularities in Moon's orbit



This may be how it works

- Upper back dial shows the Metonic sequence (235 lunar months = 19 solar years + 2 hours)
- Lower back dial shows the 223-lunar-month Saros eclipse cycle
- But not programmable
- No driving mechanism

The descendants

- The Orrery
- (Vatican Museum)

Clocks

- This one is in Mantua

Babbage's Difference Engine

- c 1870
- Science Museum, London
- Whipple Museum, University of Cambridge

Now digitally: a simulation of Toutatis

And finally

- Your own personal Antikythera!

- location of the sun, moon, and planets in the sky
- maps of stars and constellations
- rise and set time of the sun, moon, and planets
- current and future moon phases
- 3D globe view of all planets and the moon
- facts sheet for each planet, including moon names

Downloadable from http://www.qcontinuum.org/planets/ or the App. Store

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Acknowledgements

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