

CelebrityLife<sup>™</sup>  
Activities

Babylon to the Big Bang

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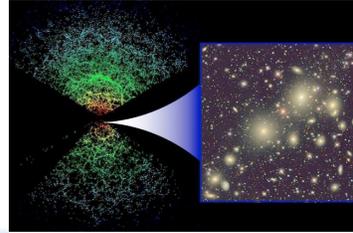
GUEST SPEAKER SERIES



Peter Watson



Babylon to the Big Bang



Peter Watson



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About myself

Peter Watson



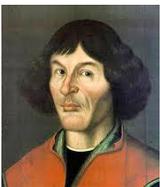
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1. The Birth of Astronomy: Stonehenge to Antikythera



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2. The Death of Astrology.



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3. Farewell to Earth.



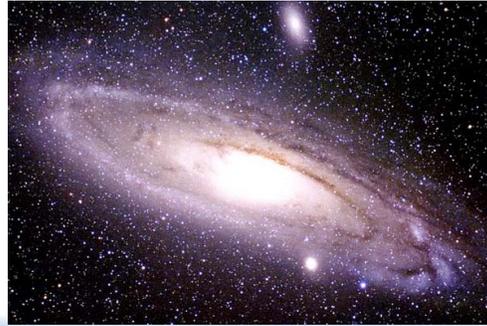
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## 4. Stars and Aliens



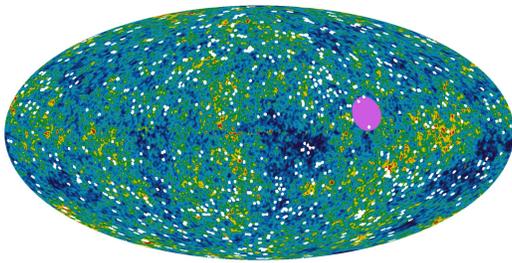
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## 5. Galaxies and beyond.



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## 6. Physics as a Creation Myth: The Big Bang.



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## The Birth of Astronomy



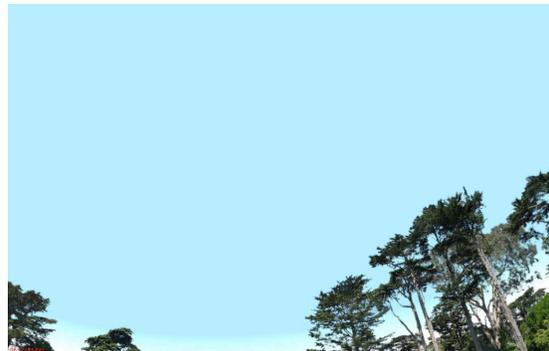
## This is Ephesus



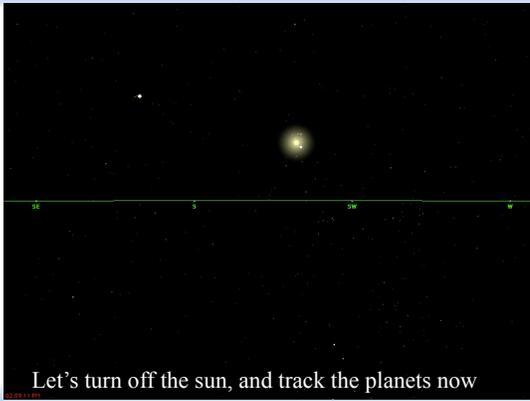
Picture by Tunc Tezel

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Sky view : Stars seem to rotate in circles, centred on the North Celestial Pole

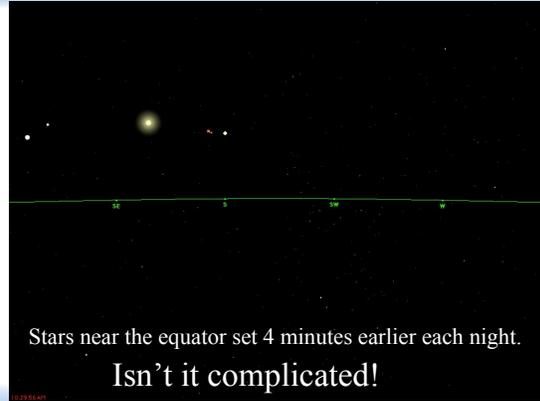


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Let's turn off the sun, and track the planets now

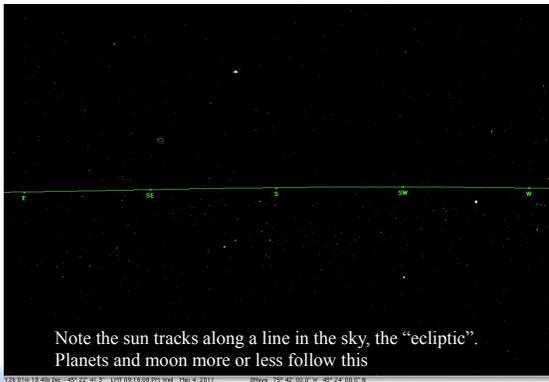
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Stars near the equator set 4 minutes earlier each night.

Isn't it complicated!

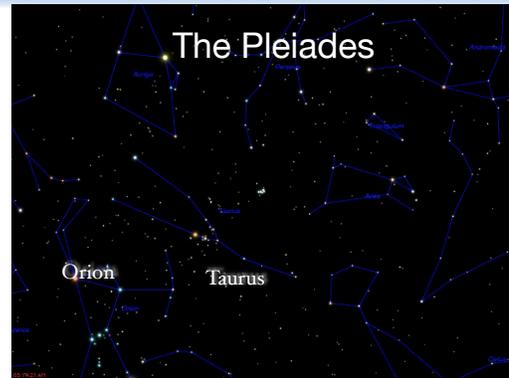
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Note the sun tracks along a line in the sky, the "ecliptic".  
Planets and moon more or less follow this

We can make things a bit easier by freezing the stars and always looking South

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The Pleiades

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## Babylon: Mul Apin tablet

On the 1st of Ayyaru the Pleiades become visible.  
On the 20th of Ayyaru Taurus becomes visible.  
On the 10th of Simanu Orion Anu and the Gemini become visible.  
On the 5th of Du'uzu the Little Twins and the Crab become visible.

[http://www.mesopotamia.co.uk/astromer/explore/exp\\_set.html](http://www.mesopotamia.co.uk/astromer/explore/exp_set.html)

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## Bible

Amos

5:7 Ye who turn judgment to wormwood, and leave off righteousness in the earth,  
5:8 Seek him that maketh the seven stars and Orion, and turneth the shadow of death into the morning, and maketh the day dark with night: that calleth for the waters of the sea, and poureth them out upon the face of the earth: The LORD is his name:

Job:

9:8 Which alone spreadeth out the heavens, and treadeth upon the waves of the sea.  
9:9 Which maketh Arcturus, Orion, and Pleiades, and the chambers of the south.

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## Nebra sky disk

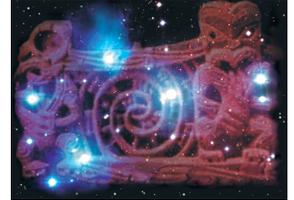


Bronze disk of ~30 cm diameter ,  
~2.2 kg, ~ 1600 BC  
Gold symbols: star cluster  
interpreted as the [Pleiades](#)).

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## Taatai Arorangi (Maori Astronomy)

- Stars are guarded by Star fairies
- One polished his star so much that the others became jealous, chased him and threw a stone which broke it in seven pieces
- Hence the Matariki (the Pleiades)



Kay Leather and Richard Hall

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## e.g. Orion



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- Appearance of Matariki (the Pleiades) marks the beginning of the New Year.
- Note complex mythology hides a **HUGE** practical application to navigation
- "If you sail for Kahiki (Tahiti) you will discover new constellations and strange stars over the deep ocean. When you arrive at the Piko o Wakea you will lose sight of Hokupaa (North Star), and the Newe (Southern Cross) will be the southern guiding-star, and the constellation of Humu will stand as a guide above you." Percy Smith

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## They also used

- Wind
- Waves (reflected from islands)
- Clouds (Land of the Long White Cloud)
- Birds

No compasses  
No Iron!

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## If you go to Hilo

- Take the tour to 'Imiloa Astronomy Centre



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Seven sisters but.....

Merope married a mortal (Sisyphus) and so faded away so we only see 6 today



Wikipedia

## In Japanese



Subaru (!): 5 stars that merged into 1

The first observatory (or the earliest we know about)



- Stonehenge
- Probably 2300 BC  $\pm$  100 years

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- Midsummer day: when the sun rises in most northerly position, sunrise aligns with "heel stone" important to define seasons and hence time to plant crops

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## Chankillo

- Much later
- Row of 13 towers on a ridge in a desert in Peru



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From observation sites the towers line up with sunrise and sunset  
Can tell date to within 2-3 days. (Ivan Ghezzi and Clive Ruggles)

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## Babylon

- Most detailed ancient observations.
- Star Catalogs 1600 BC.
- Eclipse Observed 1500 BC.
- Continuous Records 900 BC.
- Records on stone/clay tablets.

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## Enuma Elish tablets : the first (written) Creation Myth From The First Tablet

When in the height heaven was not named,  
And the earth beneath did not yet bear a name,  
And the primeval Apsu, who begat them,  
And chaos, Tiamut, the mother of them both  
Their waters were mingled together,  
And no field was formed, no marsh was to be seen;  
When of the gods none had been called into being,  
And none bore a name, and no destinies were ordained;  
Then were created the gods in the midst of heaven,

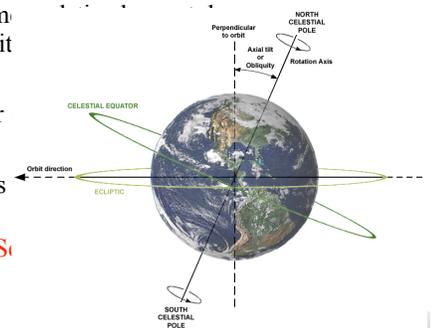
Lahmu and Lahamu were called into being...  
Ages increased,...  
Then Ansar and Kisar were created, and over them...  
Long were the days, then there came forth....  
Anu, their son,...  
Ansar and Anu...  
And the god Anu...  
Nudimmud, whom his fathers, his begetters...  
Abounding in all wisdom,...  
He was exceeding strong...  
He had no rival --

## Need some definitions (roughly as the Babylonians might have used them)

- Year: interval between (e.g) most northerly sunrises. ~365 1/4 days
- (lunar) Month: interval between (e.g.) full moons ~ 29 1/2 days
- Solar day: interval between times when the sun is due south = 24 hours (defn)
- Sidereal day: interval between (e.g.) Sirius being due south = solar day - 4 minutes

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- Midsummer's day= Sum sets in most northerly posit
- 20<sup>th</sup> or 21<sup>st</sup> June
- Midwinter's day = winter
- 21<sup>st</sup>/22<sup>nd</sup> Dec
- Spring/fall equinox: sun is are equal (roughly)
- 20<sup>th</sup>/21<sup>st</sup> March 22<sup>nd</sup>/23<sup>rd</sup> Si



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## But note

- Year is not a whole # of days
- Year is not a whole # of lunar months
- However 19 years = 235 lunar months (+ 2 hours): Metonic cycle
- Most societies fudge 12 months = 1 year by adding in extra days.

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## 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?

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**GLOUCESTER** These late eclipses in the sun and moon portend no good to us:.....

**EDMUND** I am thinking, brother, of a prediction I read this other day, what should follow these eclipses.... I promise you, the effects he writes of succeed unhappily; as of unnaturalness between the child and the parent; death, dearth, dissolutions of ancient amities; divisions in state, menaces and maledictions against king and nobles; needless diffidences, banishment of friends, dissipation of cohorts, nuptial breaches, and I know not what.

**EDGAR** How long have you been a sectary astronomical? Chinese astronomers Hi and Ho executed for failing to predict eclipse.

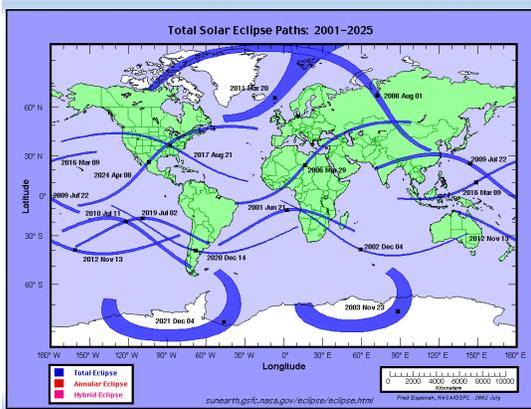
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And they even mattered to artists



St Benedict, by [Cosmas Damian Asam](#) 1735 (Weltenberg, Bavaria)

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## Saros cycle

- o Eclipses repeat after 18 years and 11.3 days.
- o The .3 days shifts the eclipse about 110° degrees west.
- o Some saros sequences start at the south and drift North, others at the North and drift South, so can only see cycle after many years.
- o Why is it so complicated? Need to combine
  1. Earth's rotation
  2. Moon's orbit (not quite circular)
  3. Earth's orbit (ditto)
  4. and the plane of the moon's orbit precesses

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## Eclipse of 1999 seen from Mir



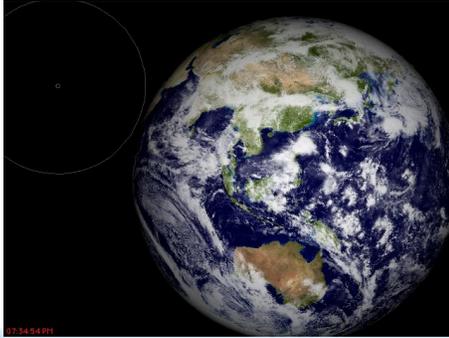
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Babylonians observed total eclipse 15 April 136 BC.

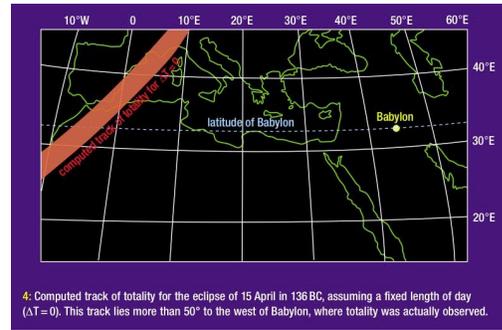


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and they would even have seen it from the moon !



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But they shouldn't have!

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

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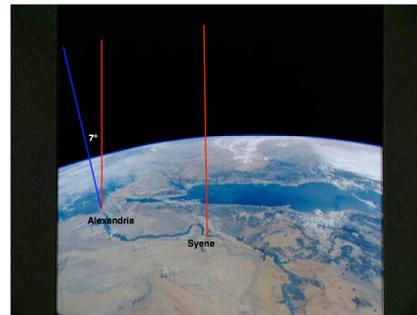
## The Greeks

- Pythagoras:
- First Cosmos Model: Motions of the Spheres.

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## Eratosthenes: 276-195 BC

How big is the earth?



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- Sun is vertically above Syene (Aswan) whereas it is  $7^\circ$  off the vertical at Alexandria,
- Distance is 720 km
- Gives  $\sim 5900$  km instead of 6400.
- First step into finding how big the universe is!
- How far is the Moon?

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Photo by Anthony Ayiomitis

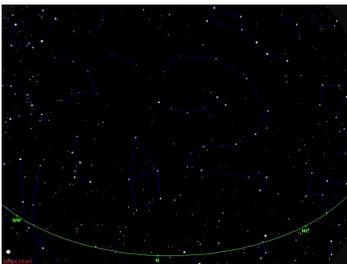
- Moon is about  $1/2^\circ$  in the sky
- Can use the moon as a "Screen" on which the shadow of the earth is projected:
- The shadow of the Earth  $\sim 2^\circ$  wide.

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- Radius of the earth ~6500 km (4000 mi).
- This gives  $d \sim 375,000$  km
- $d = 384,400$  km by modern methods.
- How far is the sun?

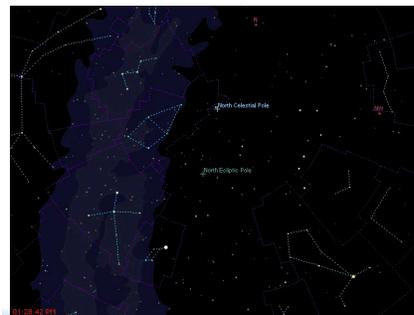
- **Estimate** earth-sun distance ~20 times Earth-Moon distance ~7,500,000 km. (actually ~150,000,000 km)
- Implies the sun is a red-hot stone bigger than Greece! (Anaxagoras)

### One more discovery by the Babylonians/Greeks



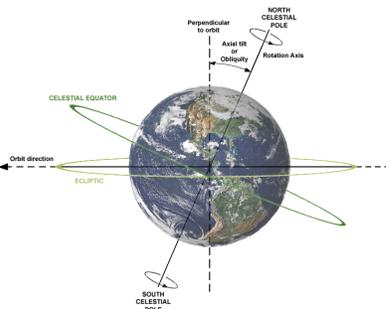
- What is the North star?
- The point the stars appear to rotate round

### Hipparchus: 160-127 BC. Precession of the Equinoxes

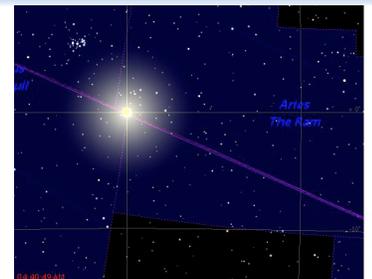


Earth's axis is tilted, but doesn't always point to the same place (i.e. the North Star isn't always!)

- March 21st & Sept 21st are special days: the equinoxes
- Sun is above the equator, but where on the equator?



- Aries 2000 BC
- Pisces 100 BC
- (which is why the Christians chose the fish as their symbol)

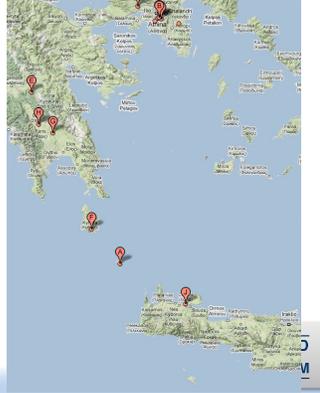


• And now

• This is the dawning of the age of Aquarius

# Antikythera

- Wreck full of sculptures



# and a piece of rusted junk: Antikythera Mechanism



Found in 1901  
probably late second  
century BC.  
National Archaeological  
Museum in Athens  
So what is it?



X-rays show very complex  
structure  
Many (at least 30) gears: one  
has 47 teeth !!!!



# This may be how it works



- Shows Metonic sequence (235 lunar months = 19 solar years + 2 hours)
- $235 = 5 \times 47$ !!!!!!!!!!!!!!!!!!!!!!
- Shows Saros eclipse cycle (223 lunar months)



2010:  
A fully functional replica of  
the Antikythera Mechanism is built



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# Acknowledgements

## Astronomy Picture of the Day (APOD)

Anthony Ayiomitas

Tunc Tezel

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Planets: Dana Peters <[dana@qcontinuum.org](mailto:dana@qcontinuum.org)>, Downloadable from the App. Store

