

## Origins of Cosmology



Friday, September 25

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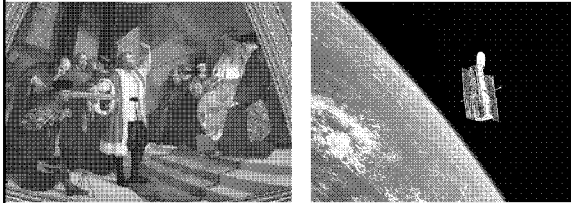
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Cosmology is based on **observation** of the universe around us.



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Looking WSW, 5:30 pm today

Sun ↑

Sky (blue)

horizon

Earth (opaque)

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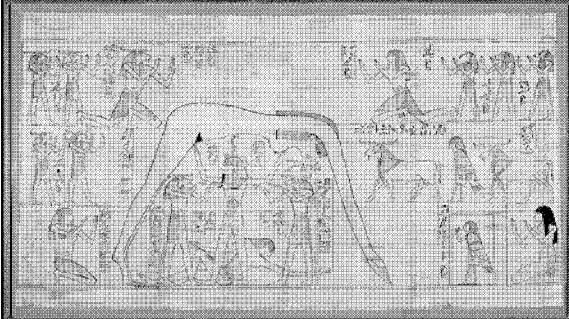
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Cosmology version 1.0:  
Domed sky over flat earth.



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And God said, "Let there be a vault in  
the midst of the waters, and let it  
divide water from water." And God  
made the vault and it divided the  
water beneath the vault from the  
water above the vault, and so it was.  
– Genesis 1:6  
[Robert Alter translation]

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Aristotle (4<sup>th</sup> century BC): First to give  
reasons why the Earth is spherical.

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Aristotle's 1<sup>st</sup> reason:

Gravity pulls matter to center of Earth, compressing the Earth into as compact a shape as possible.

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2<sup>nd</sup> reason:

You see different stars from the south than from the north.



Big Dipper



Southern Cross



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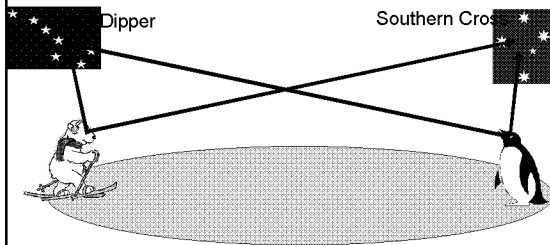
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If the Earth were flat:



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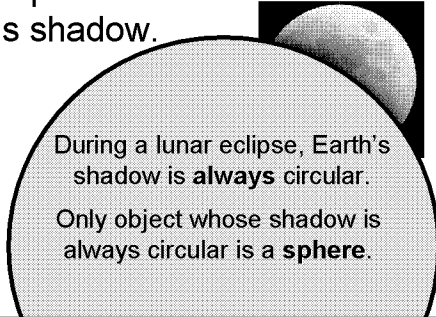
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3<sup>rd</sup> reason:

The shape of the  
Earth's shadow.



During a lunar eclipse, Earth's shadow is **always** circular.

Only object whose shadow is always circular is a **sphere**.

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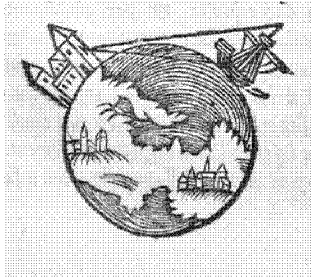
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Other reasons were given later:



Ships disappear "hull-down".

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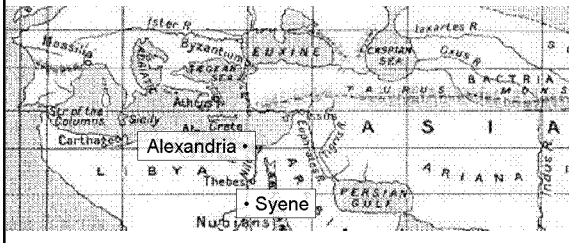
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How large is the Earth?

Question answered by  
**Eratosthenes** (ca. 200 BC).



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What Eratosthenes **read**: At noon on June 21, Sun is at zenith seen from Syene.

What he **saw**: At noon on June 21, Sun is  $7.2^\circ$  south of zenith seen from Alexandria.

What he **assumed**: Earth is spherical:  
Sun is very far away.

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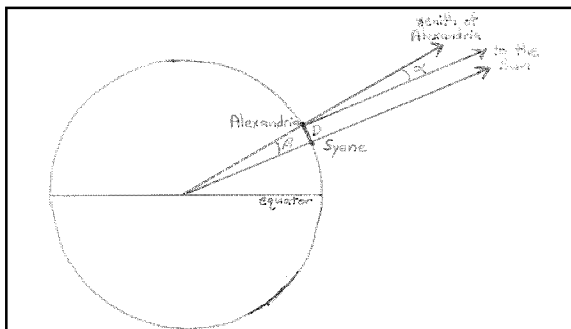
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Angle  $\alpha$  = angle  $\beta$  =  $7.2^\circ$  =  $1/50$  of circle.  
Distance  $D$  =  $1/50$  of circumference.

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Circumference of Earth =  $50 \times$  distance  
from Alexandria to Syene.

Distance from Alexandria to Syene =  
5000 stades

Circumference of Earth =  $50 \times 5000$   
stades = 250,000 stades.

(about 46,000 kilometers –  
true value is 40,000 kilometers)

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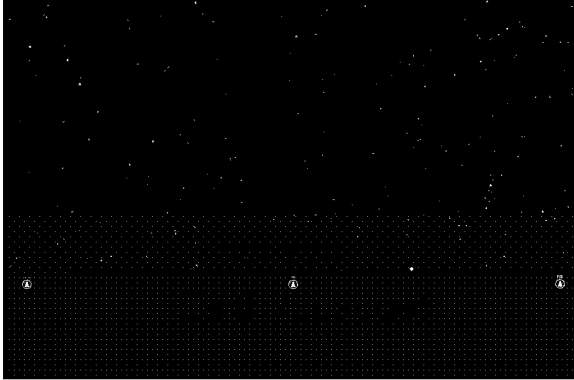
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Looking north, 8:30 tonight.



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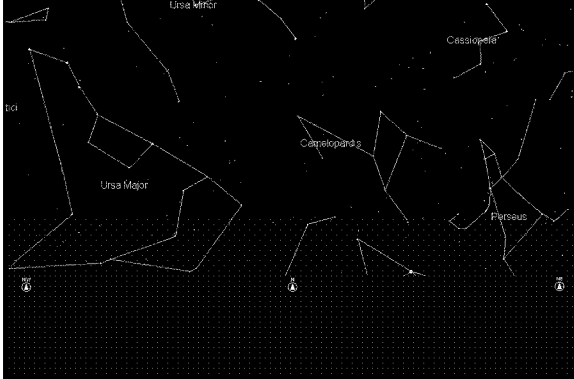
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Constellations



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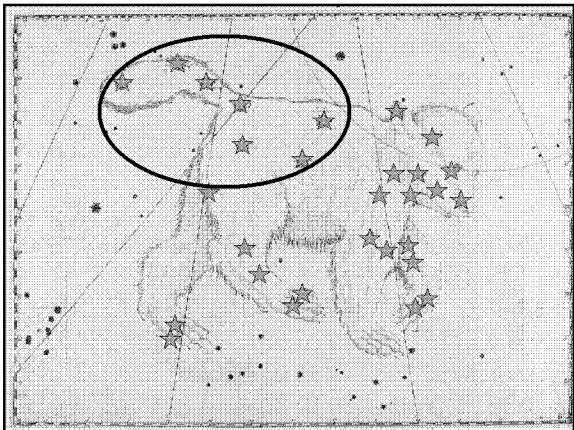
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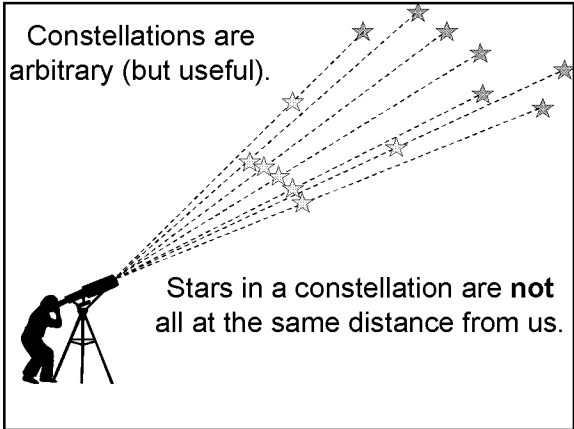
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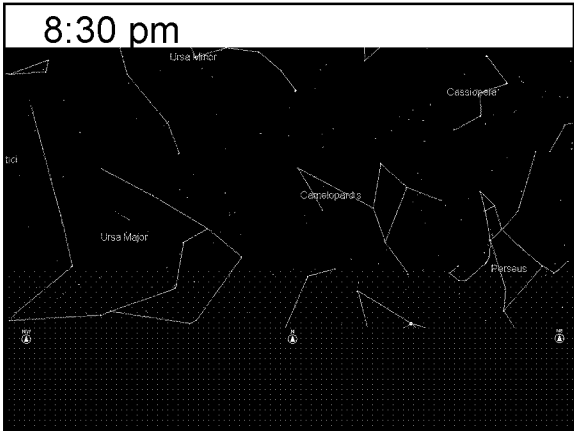
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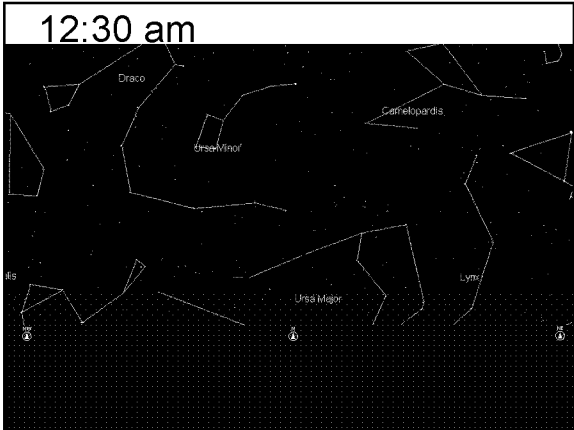
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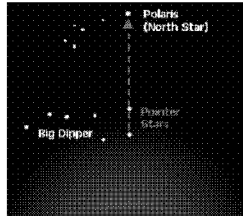


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Constellations appear to travel in counterclockwise circles around Polaris (the North Star).



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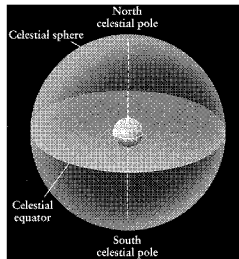
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Strong visual illusion: stars are attached to a **celestial sphere**, rotating around the Earth.



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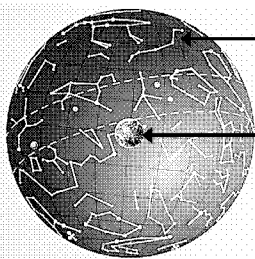
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Cosmology version 2.0:  
Celestial sphere surrounding spherical Earth.



Stars attached to celestial sphere, which rotates.

Earth stationary at center.

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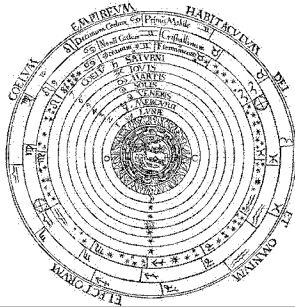
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This **geocentric** (Earth-centered) model was generally accepted from ancient times until 16<sup>th</sup> cent. AD.



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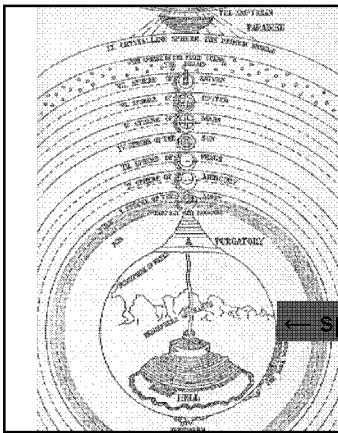
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Dante  
Divine Comedy  
AD 1300

← spherical Earth

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Monday's Lecture:  
Ancient Cosmology  
Please read these chapters  
in the text:  
Chapters 1 & 2

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