Mathematics and Understanding the Universe

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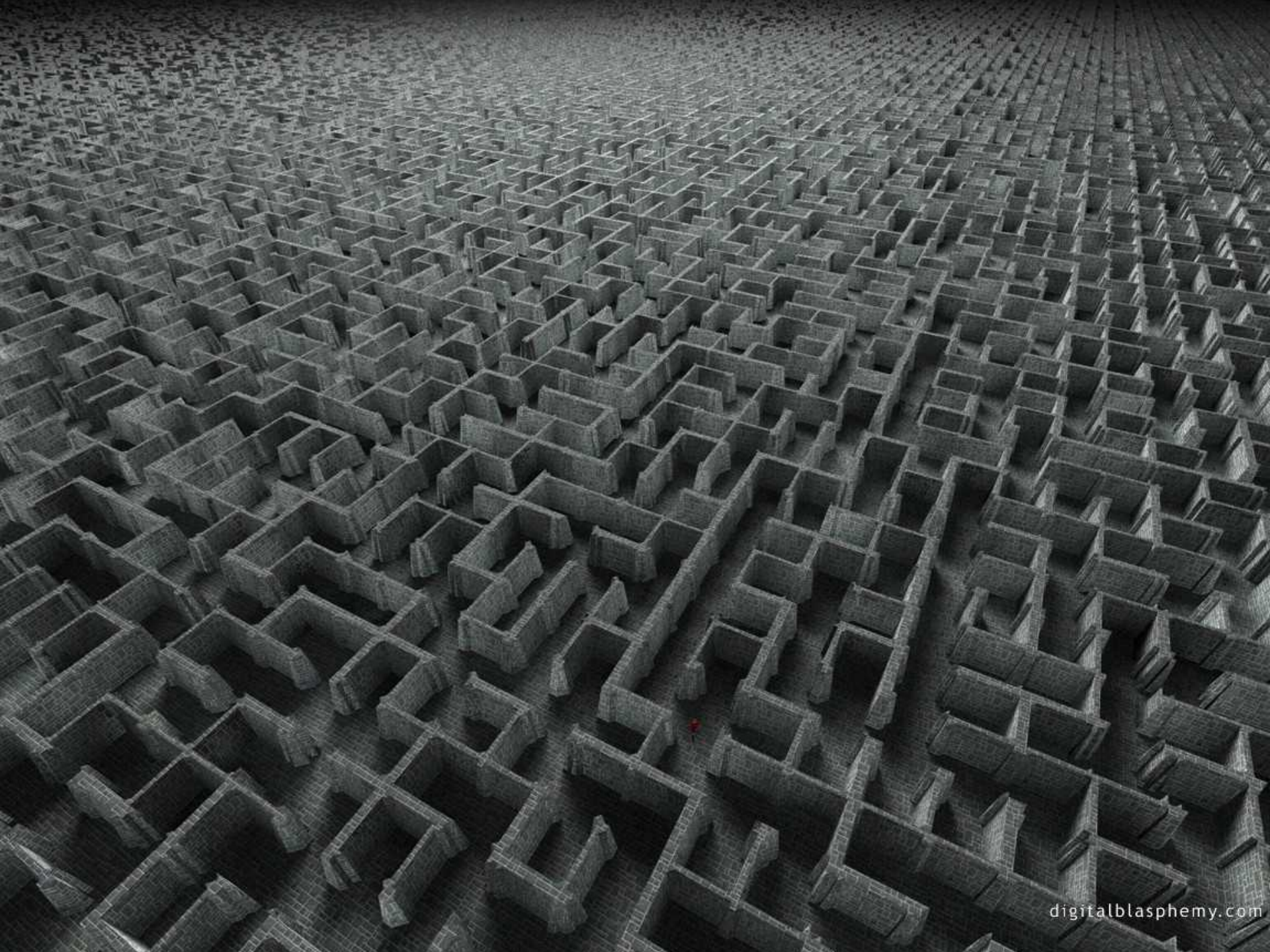
- A couple of calculation
- Place of Mathematics
- Observation/verification (data/theory)
- Discussion


digitalblasphemy.com

- Mercury and Venus

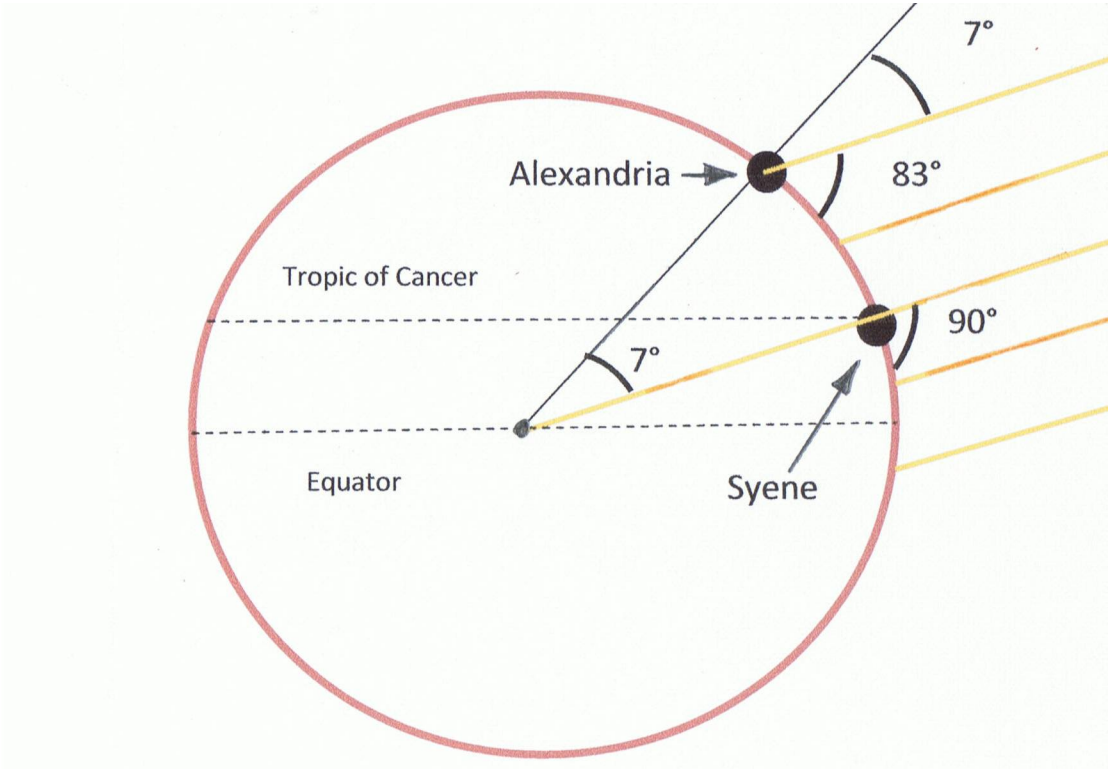
The Earth flat!

The earth is the center of the universe.

- The simplicity of the Mathematics in the calculations

Eratosthenes 276-194 BC

Eratosthenes 276-194 BC



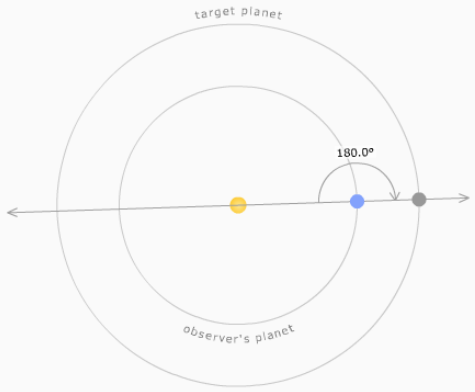
Aristarchus of Samos 310-230BC

distance to the moon.mp4

Planetary Configurations Simulator

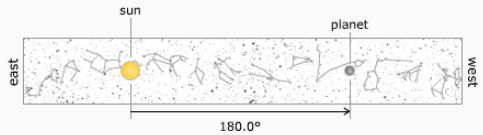
reset help about

Diagram



☑ label orbits
☑ show elongation angle ☑ snap to events when dragging planets

Zodiac Strip



Orbit Sizes

radius of observer's planet's orbit:
1.00 AU Earth

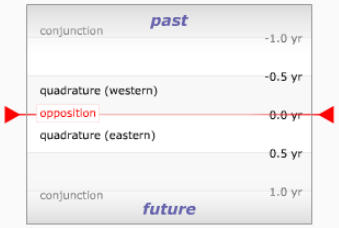
radius of target planet's orbit:
1.52 AU Mars

Animation Controls

speed: start animation

when an event occurs...
○ stop ◉ keep going ○ pause for 5 seconds

Timeline



counter: 0.000 years

zero counter

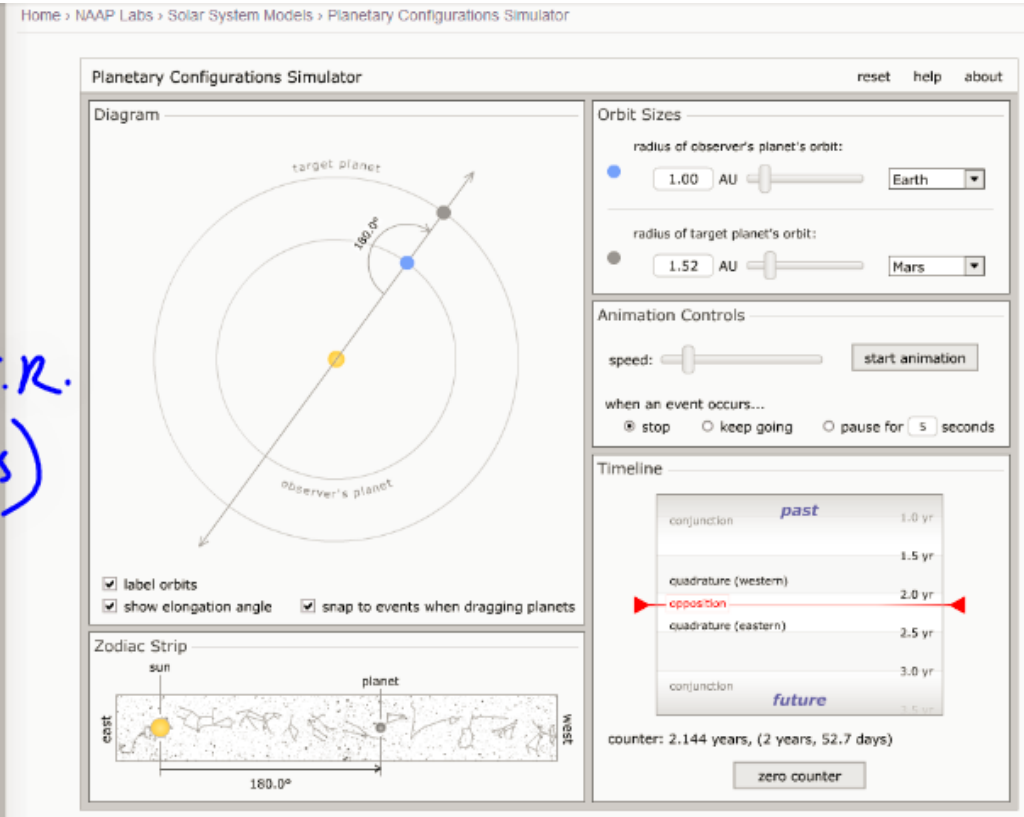
2.144 E.R

1.144 M.R

$\frac{1.144}{2.144} = \frac{1}{X}$

$X = 1.874$ E.R.

(685 days)



0.291 E.R

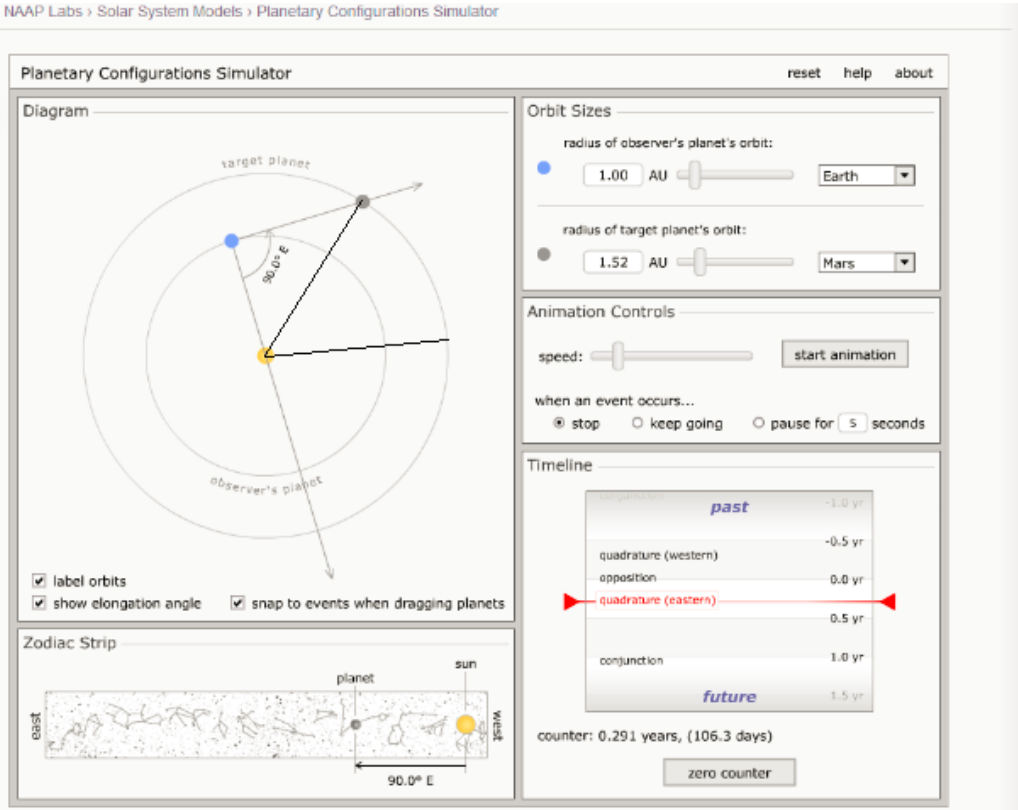
$0.291 \times 360 = 105^\circ$

$\frac{0.291}{1.874} \times 360 = 56^\circ$

$105^\circ - 56^\circ = 49^\circ$

$\cos 49^\circ = \frac{1\,AU}{Dm}$

$Dm = 1.52\,AU$



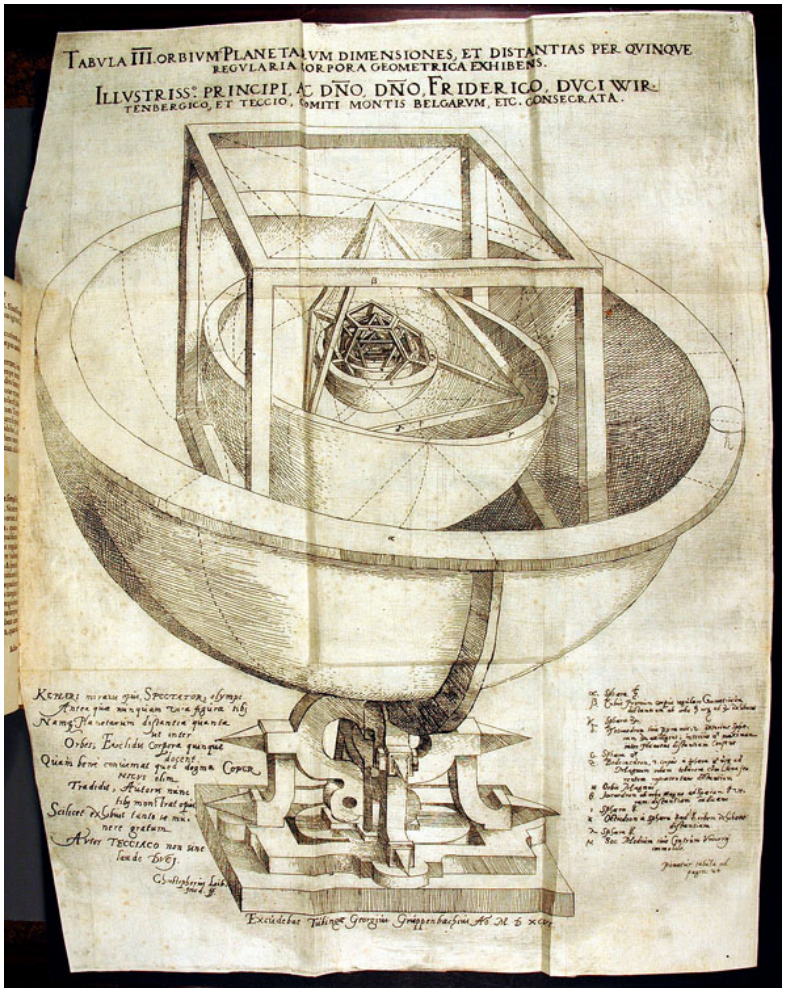
- Ellipse/Circle/Square

- The connection between us and the universe
- Can Mathematics serve as a manual?
- Abstraction: Holding the idea of something in the absence of the concrete
- Can mind be freed?

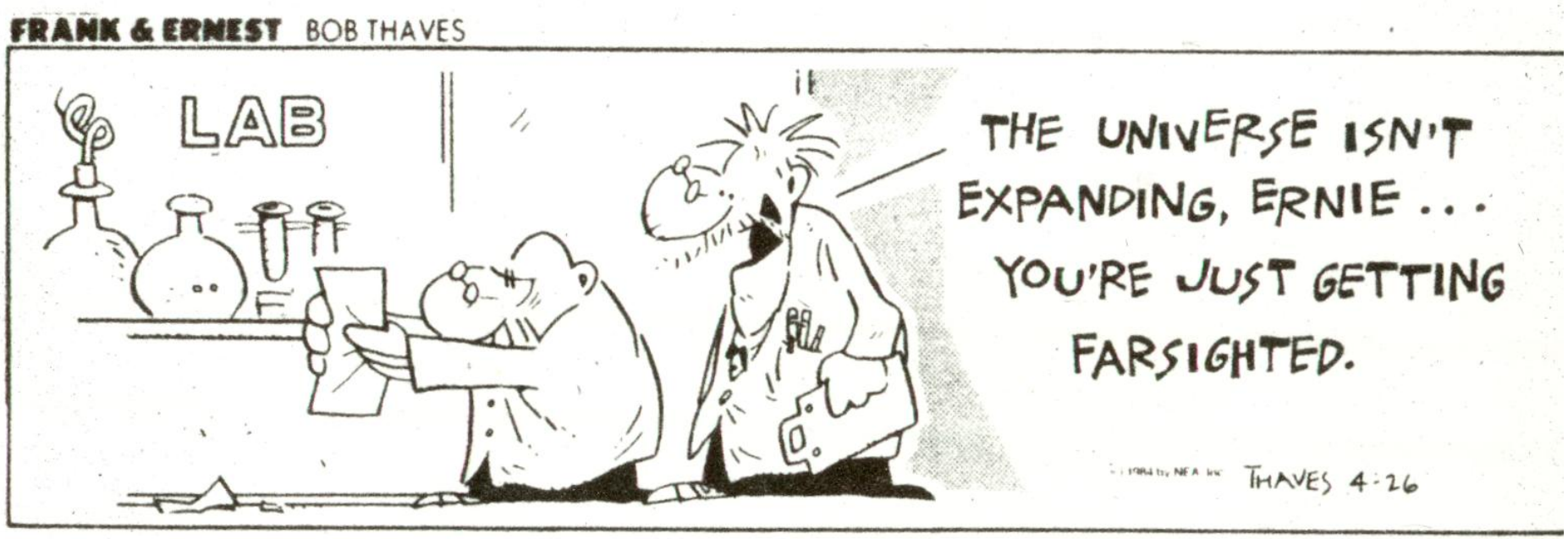
- Tycho Brahe 1546-1601
- Johannes Kepler 1571-1630
- Galileo Galilei 1564-1642

Tycho Brahe and Johannes Kepler

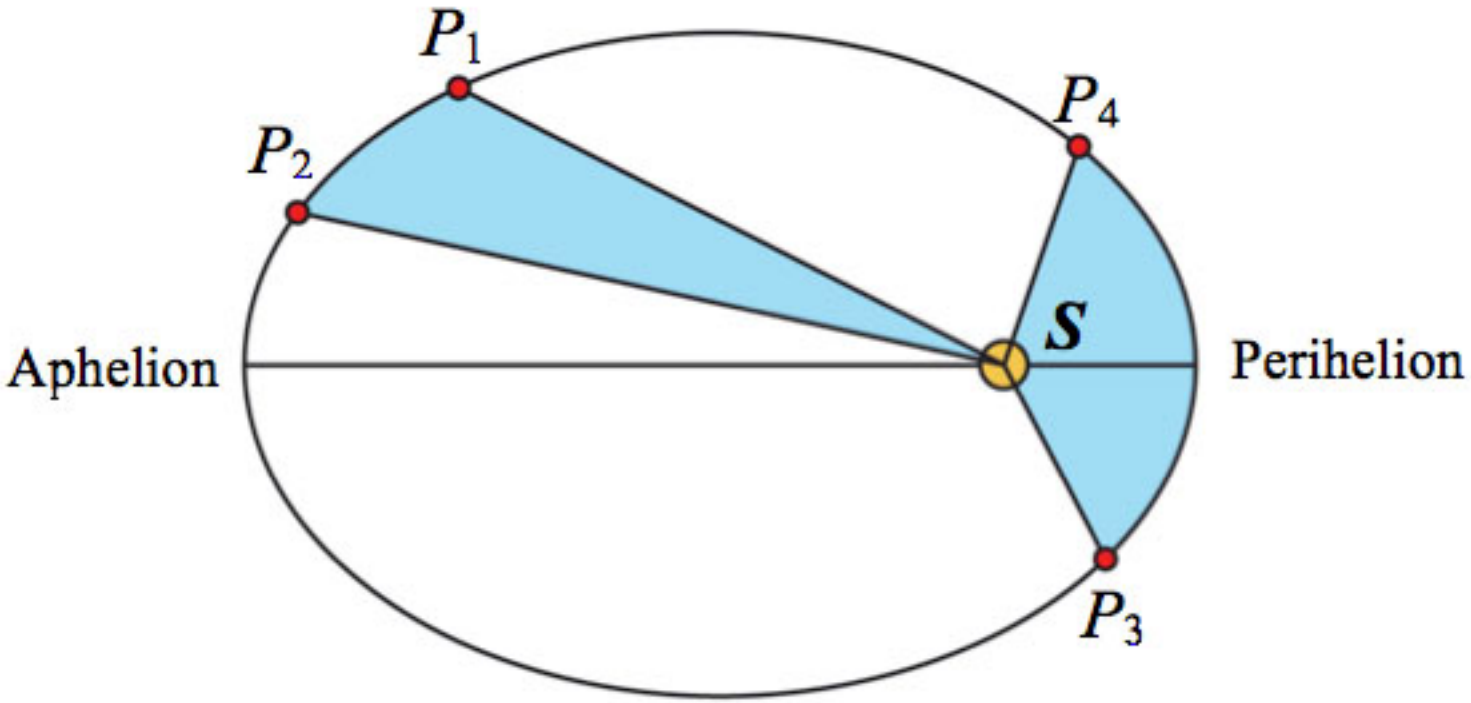
Johannes Kepler, *Mysterium Cosmographicum* (1596), diagram of the planetary spheres

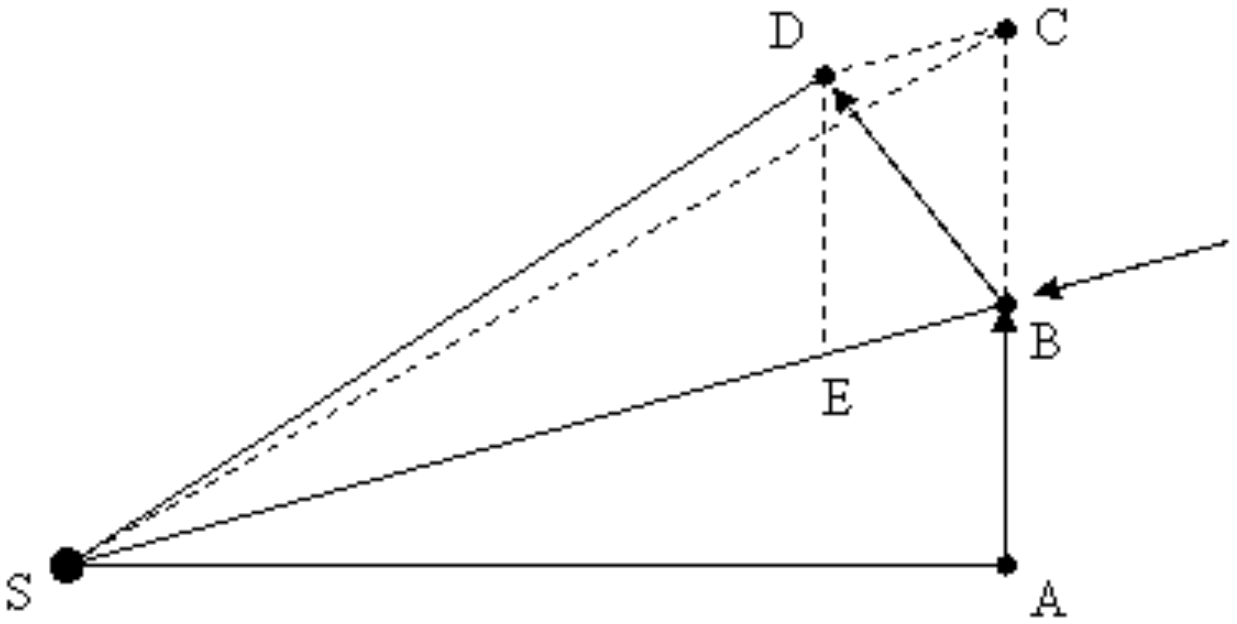


Collecting information and putting it together

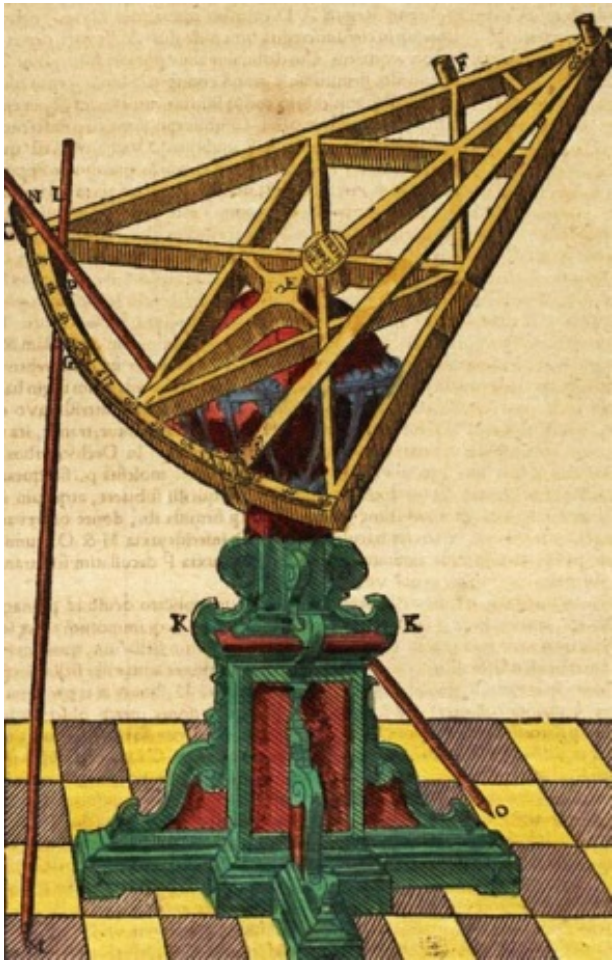


Equal areas

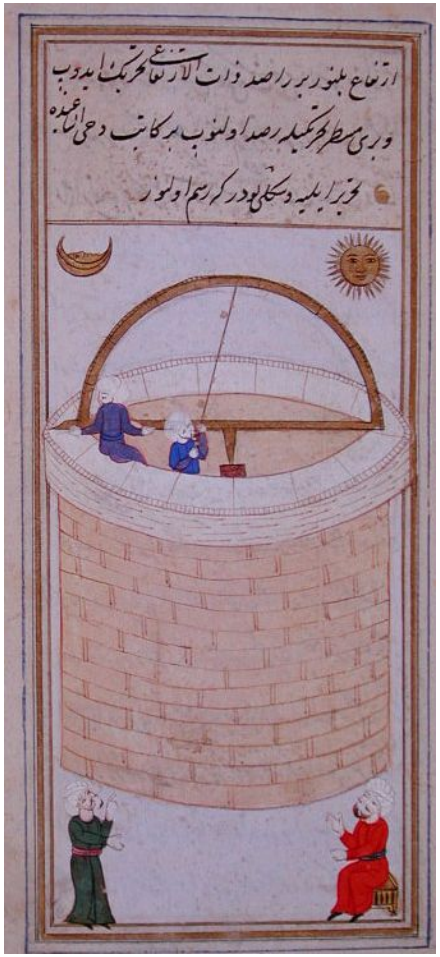


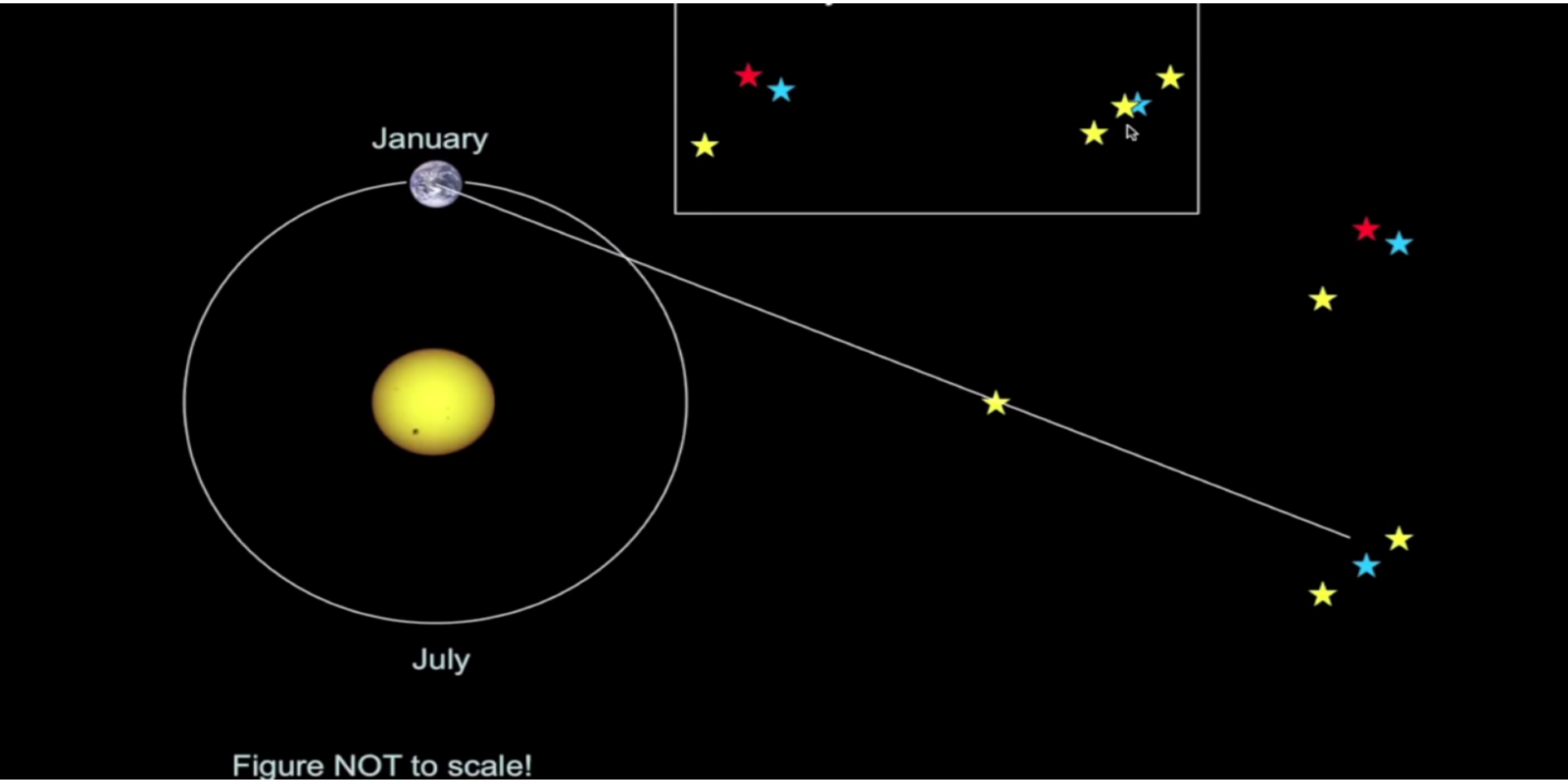

D
C
B
E
S
A

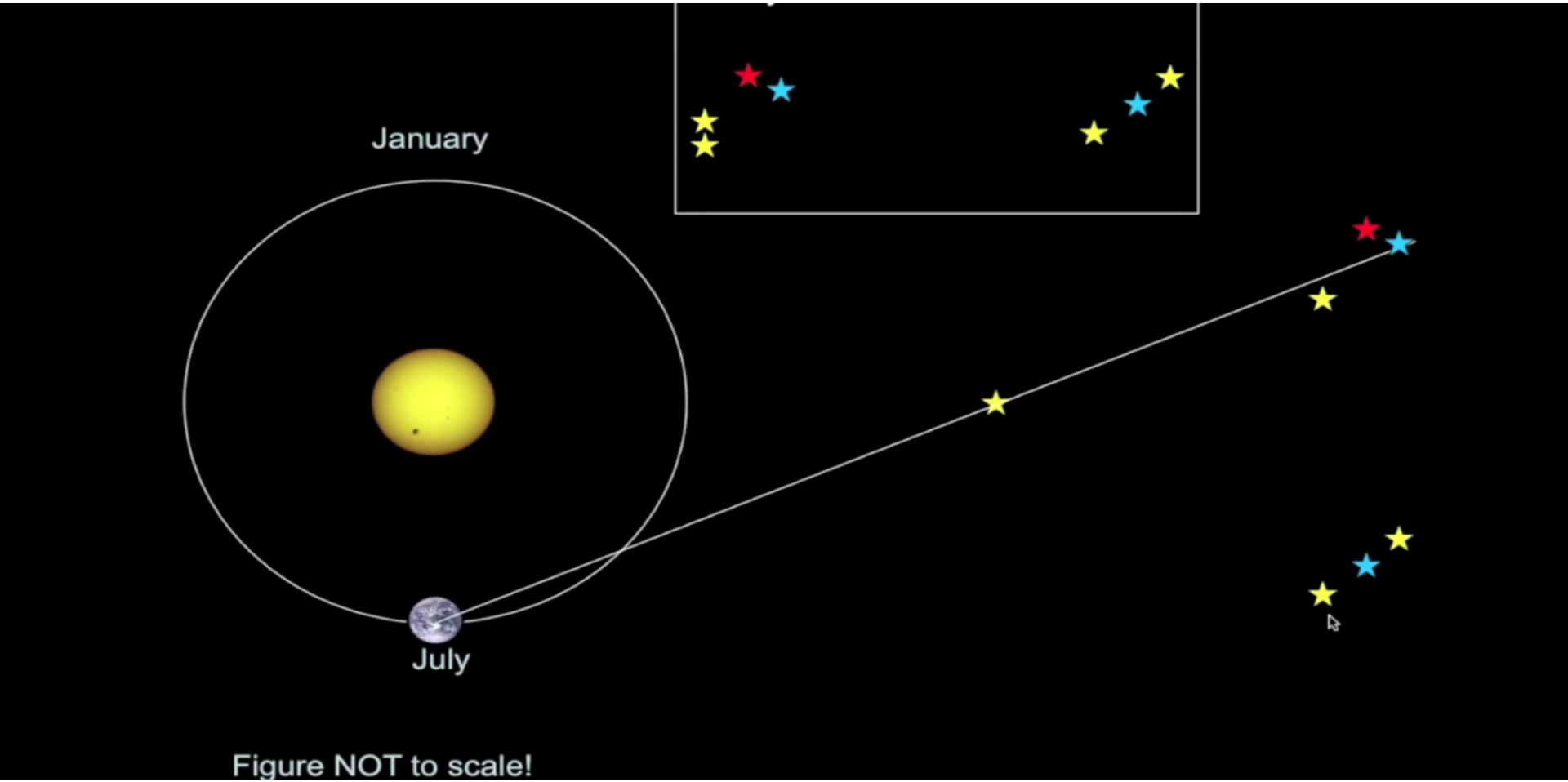
taqi ad din 1525 & tycho1546 sextant



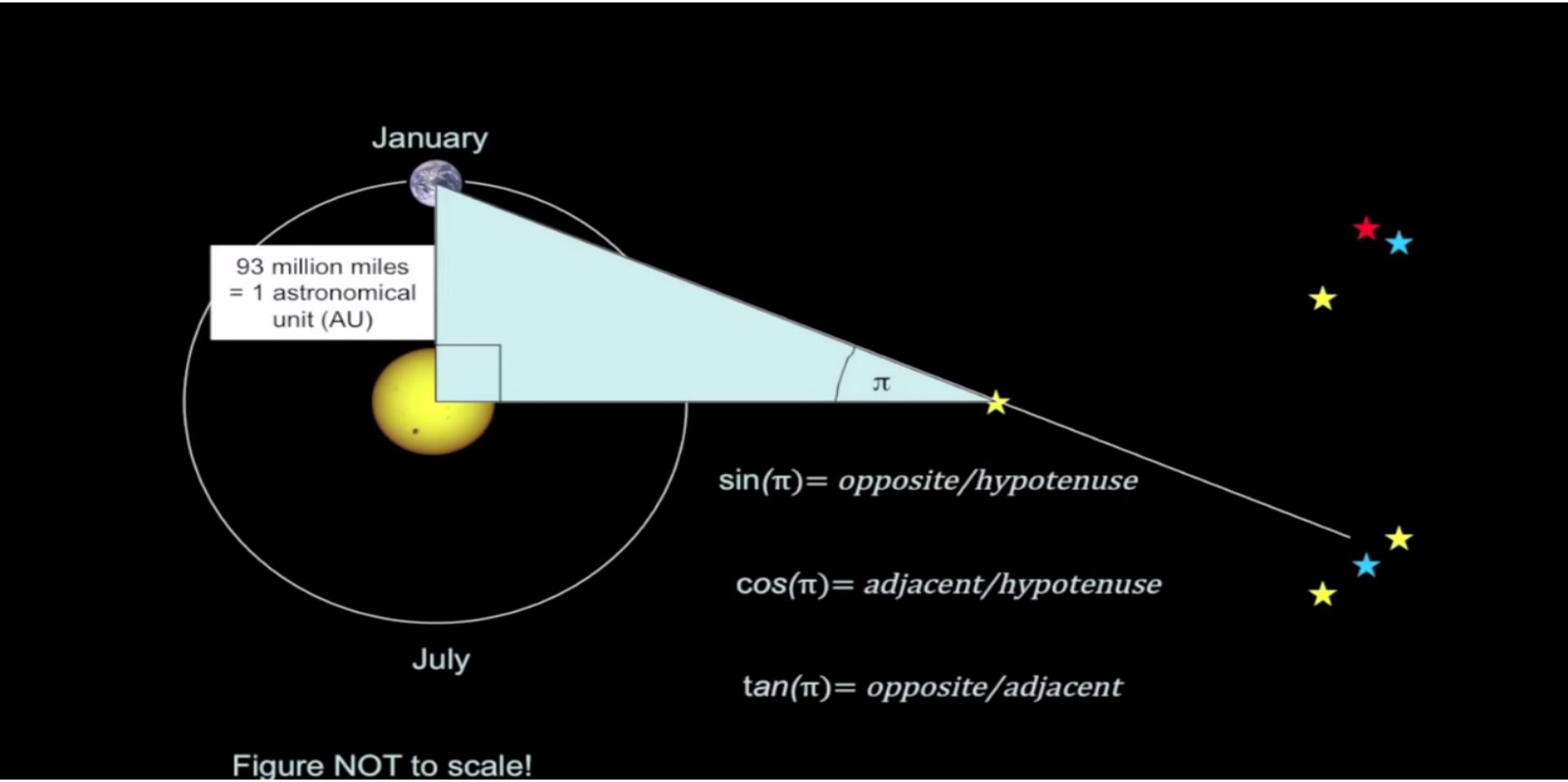
Tycho Brahe Sextant

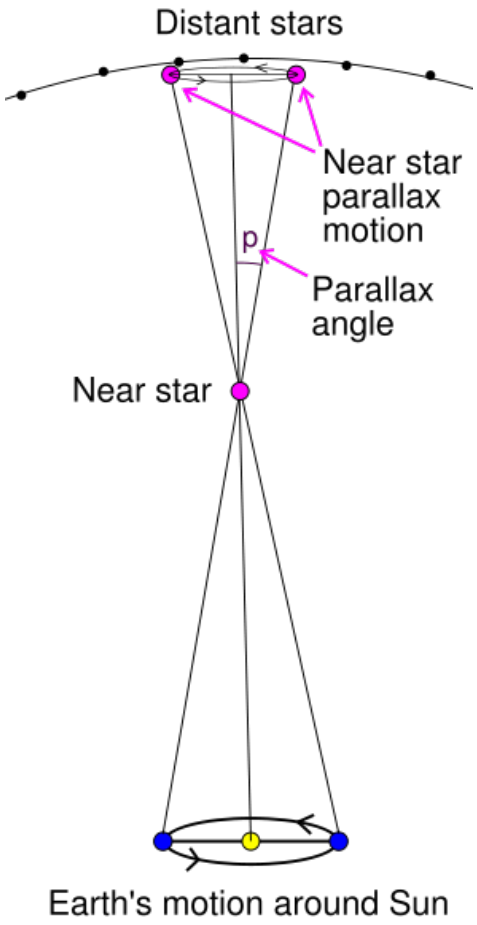


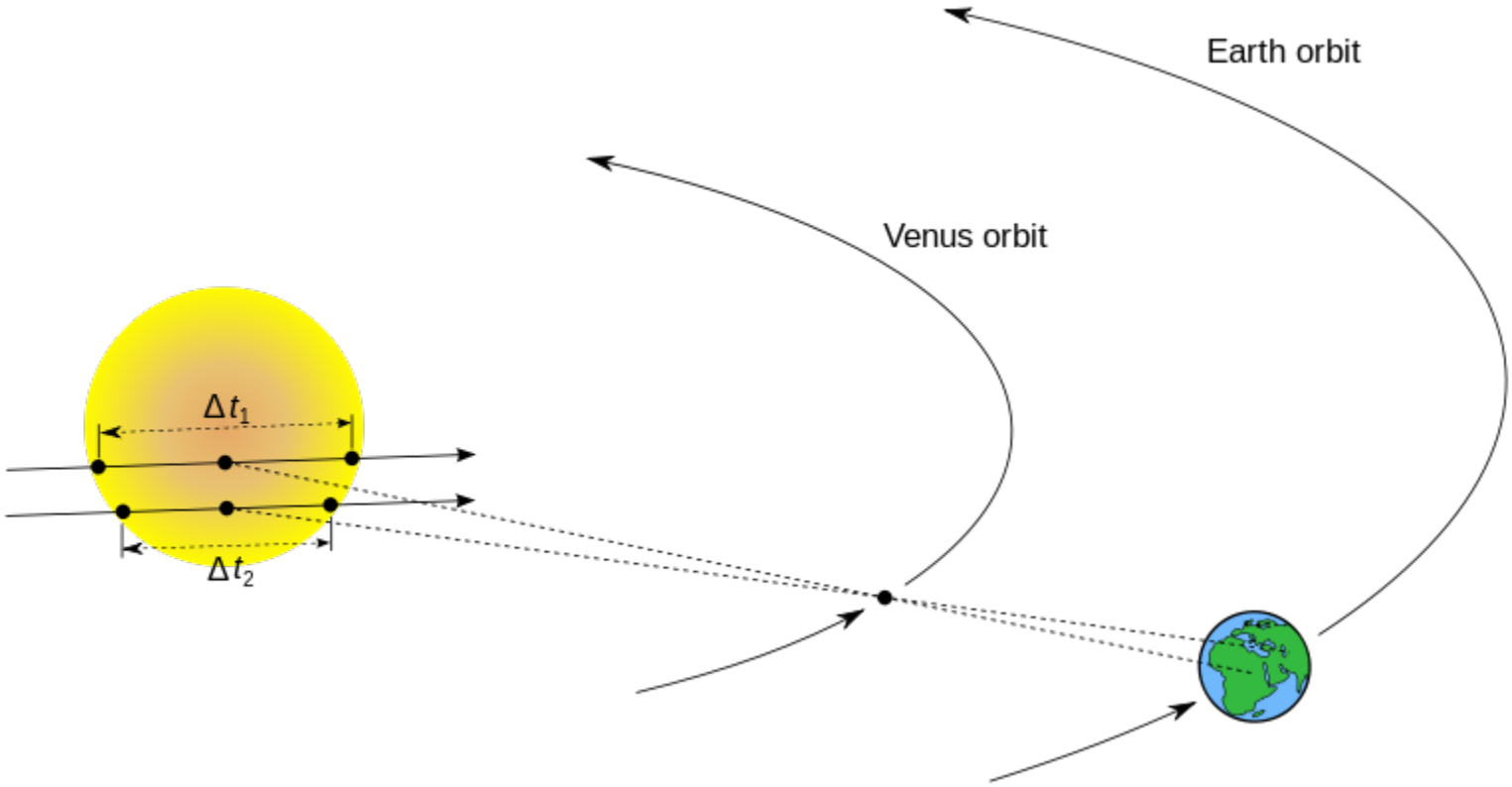

January
July
Figure NOT to scale!

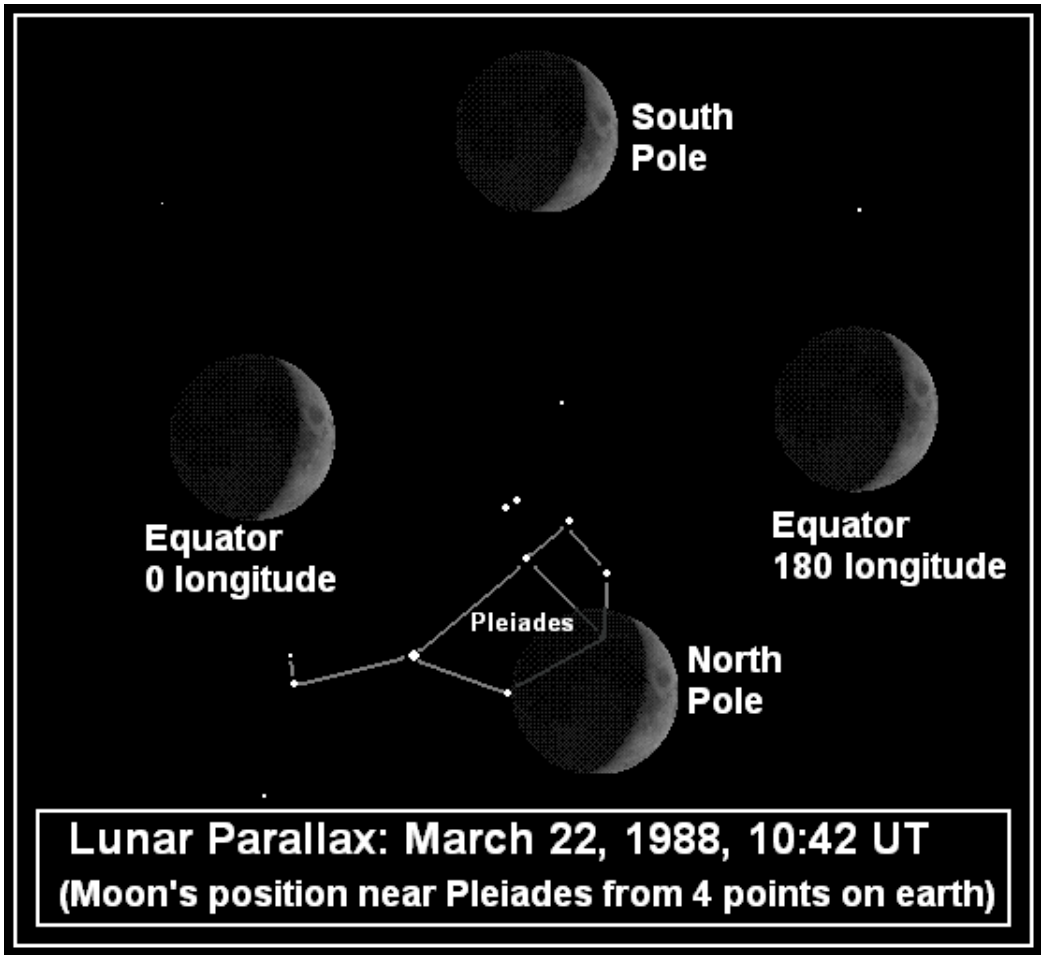

January
July
Figure NOT to scale!

Difficult to measure & Tycho's case




Distant stars
Near star parallax motion
p
Parallax angle
Near star
Earth's motion around Sun


Earth orbit
Venus orbit
Δt_1
Δt_2


South
Pole
Equator
0 longitude
Equator
180 longitude
Pleiades
North
Pole
Lunar Parallax: March 22, 1988, 10:42 UT
(Moon's position near Pleiades from 4 points on earth)

- Mathematics as a way of keeping simple record of logic

James Maxwell equations

$$\frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z} = 4\pi\rho \qquad (1)$$

$$\frac{\partial B_x}{\partial x} + \frac{\partial B_y}{\partial y} + \frac{\partial B_z}{\partial z} = 0 \qquad (2)$$

$$\left.\begin{aligned} \frac{\partial E_x}{\partial x} - \frac{\partial E_y}{\partial y} + \frac{1}{c}\dot{B}_z = 0 \\ \frac{\partial E_y}{\partial z} - \frac{\partial E_z}{\partial y} + \frac{1}{c}\dot{B}_x = 0 \\ \frac{\partial E_z}{\partial x} - \frac{\partial E_x}{\partial z} + \frac{1}{c}\dot{B}_y = 0 \end{aligned}\right\} \qquad (3)$$

$$\left.\begin{aligned} \frac{\partial B_x}{\partial y} - \frac{\partial B_y}{\partial x} - \frac{1}{c}\dot{E}_z = \frac{4\pi}{c} j_z \\ \frac{\partial B_y}{\partial z} - \frac{\partial B_z}{\partial y} - \frac{1}{c}\dot{E}_x = \frac{4\pi}{c} j_x \\ \frac{\partial B_z}{\partial x} - \frac{\partial B_x}{\partial z} - \frac{1}{c}\dot{E}_y = \frac{4\pi}{c} j_y \end{aligned}\right\} \qquad (4)$$

Original form

$$\nabla \cdot \mathbf{E} = 4\pi\rho \qquad (1)$$

$$\nabla \cdot \mathbf{B} = 0 \qquad (2)$$

$$\nabla \times \mathbf{E} + \frac{1}{c}\dot{\mathbf{B}} = 0 \qquad (3)$$

$$\nabla \times \mathbf{B} - \frac{1}{c}\dot{\mathbf{E}} = \frac{4\pi}{c}\mathbf{j} \qquad (4)$$

Simplified using rotational symmetry

$$\partial_\nu F^{\mu\nu} = \frac{4\pi}{c} j^\mu \qquad (1 \text{ and } 4)$$

$$\varepsilon^{\mu\nu\kappa\lambda}\,\partial_\nu F_{\kappa\lambda} = 0 \qquad (2 \text{ and } 3)$$

Further simplified using the symmetry of special relativity

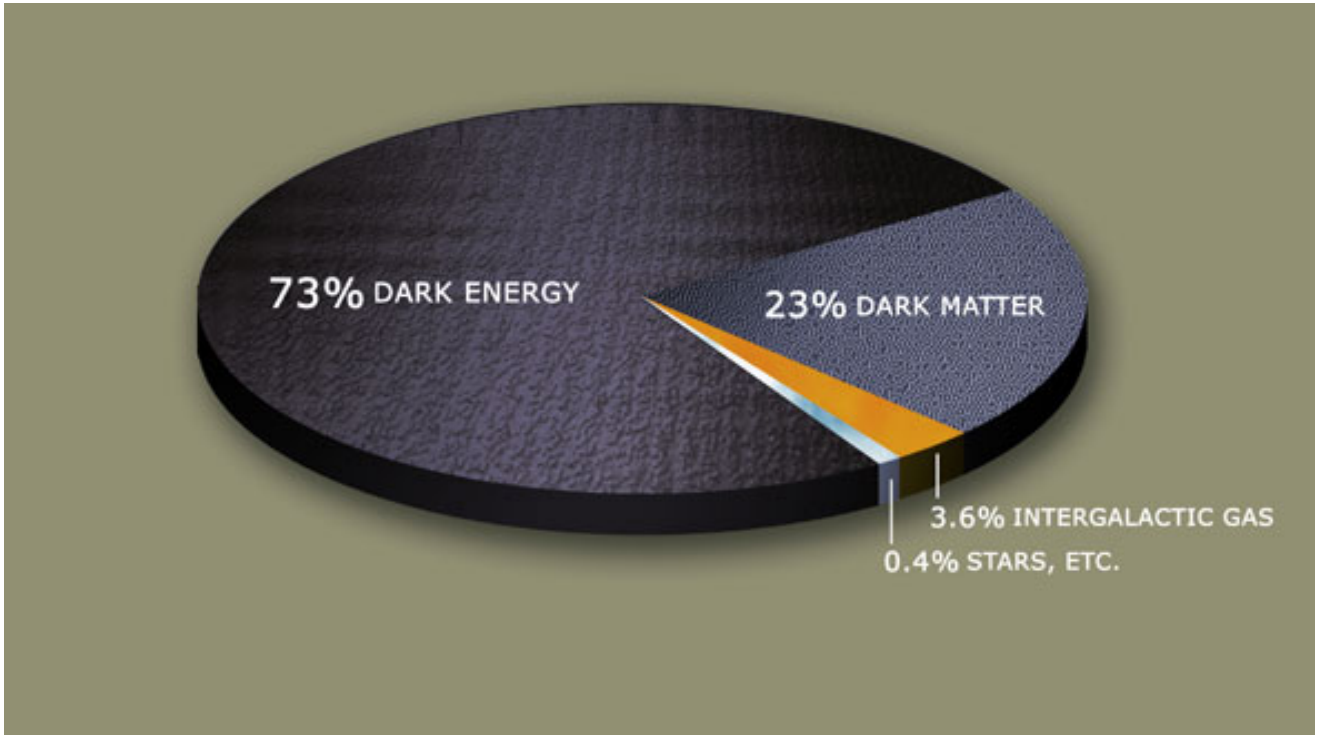
- Irrational numbers/Vectors/Calculus
- What will Mathematics look like in the future?
- Mathematics and our physical experience

New way of observing

Data collection/observation

different ways to look at the universe.mp4

Darkness!


73% DARK ENERGY
23% DARK MATTER
3.6% INTERGALACTIC GAS
0.4% STARS, ETC.

- Labirynth image - http://sciencefiction.com/2013/04/12/disney-picks-up-labyrinth-from-black-list-writer/
- A Hila Science Video - How to estimate… http://www.youtube.com/watch?v=zioSpV2yq24
- BBC Extreme Astronomy - Seeing Stars http://www.youtube.com/watch?v=IvIGrb3Eyw4
- Distance to Mars diagram - http://astro.unl.edu/naap/ssm/ssm.html
- James R Voelkel http://chapin.williams.edu/pasachoff/classics.html
- Murray Gell-Mann: Beauty, truth and ... physics? Electric charges and currents give rise to all the electric and magnetic fields there is no magnetism other than that some day we might find a hole in that argument - http://www.ted.com/talks/murray_gell_mann_on_beauty_and_truth_in_physics.html
- Patricia Burchat: Shedding light on dark matter. - http://www.ted.com/talks/patricia_burchat_leads_a_search_for_dark_energy.html
- esa - Abell 2218 - http://www.spacetelescope.org/images/heic0814a/
- http://www.pa.msu.edu/courses/2007spring/ISP205/sec-2/L04-26.pdf