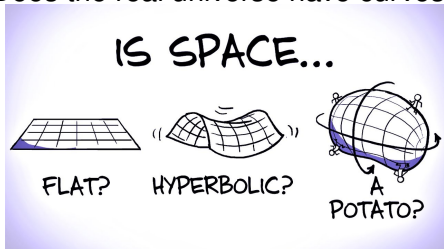


Geometry of the Earth and Universe

How we measure and view the world around us and decide what is the nature of reality: What does a geometric space look like, how do we know, and how do we represent it? Possibilities and real-world applications...

- diverse perspectives including local to global connections
- truth & consequences, the role of chance and probability
- ways that diverse people succeed in and impact mathematics
- what mathematics is & offers

Does the real universe have curves?



minutephysics What Is The Shape of Space? (ft. PhD Comics)
<https://www.youtube.com/watch?v=oCK5oGmRtXQ/>

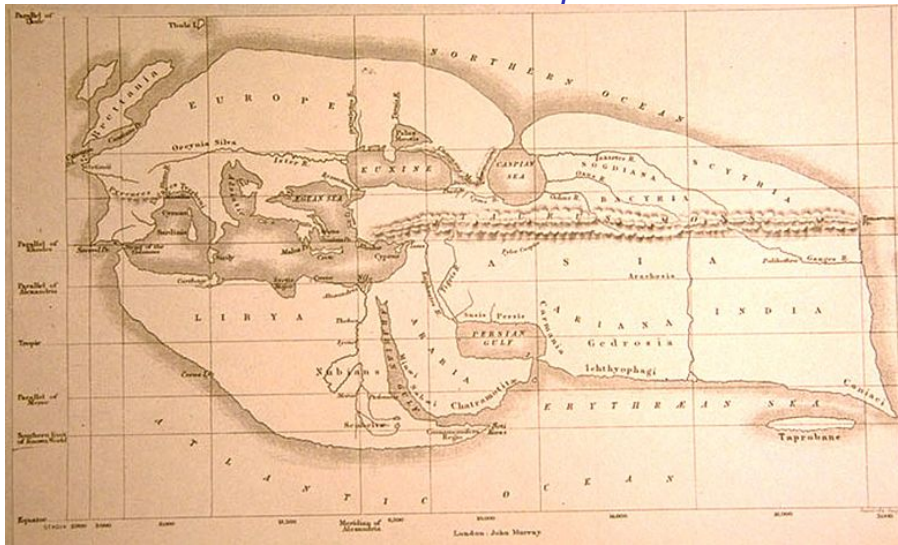
Discussion Question

💡 How could we know that the earth is a round sphere without using technology from the 20th or 21st centuries?



http://gstene.files.wordpress.com/2008/08/flat_earth.jpg

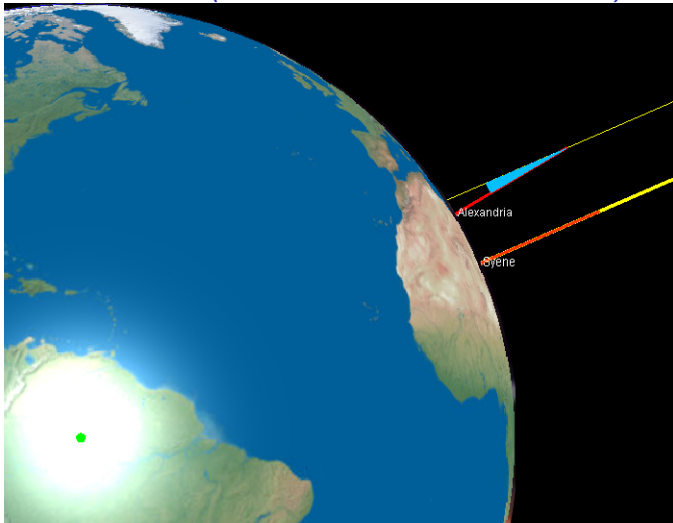
A View of the Earth—Once Upon a Time



E.H. Bunbury



Eratosthenes' (~276 BCE – ~195 BCE) Data



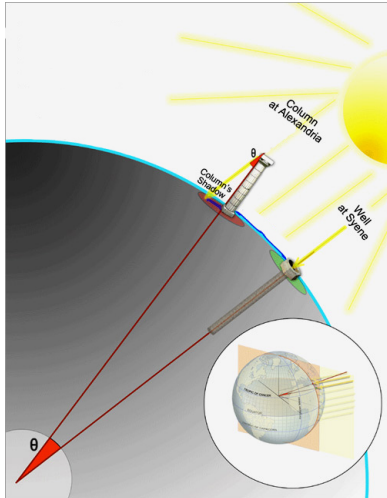
Creative Commons Attribution-Share Alike 3.0 Unported

Todd Timberlake, remixed by lookang, version public domain earth from Tom Patterson

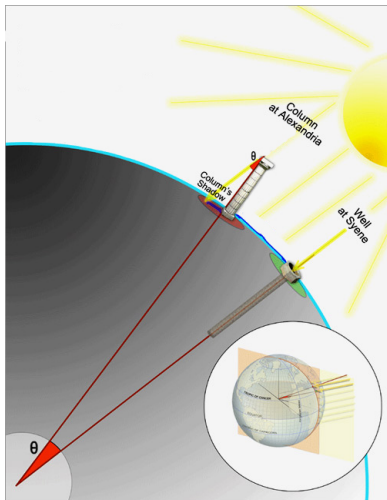
<http://weelookang.blogspot.sg/2012/06/ejs-open-source-eratosthenes-measures.html>



Eratosthenes Thinks Big (Globally!)



Eratosthenes Thinks Big (Globally!)



$$\frac{7.2^\circ}{360^\circ} = \frac{5000 \text{ stadia}}{\text{circumference}}$$

http://www.freewebtown.com/gr_math/mathimatikoi_astr/eratosthenes_of_cyrene_m.htm

Local to Global: Multiple Perspectives

💡 How could we know that the earth is round without using modern technology?

Geography

Philosophy

Physics & Astronomy

Mathematics

Navigation

Weather

Local to Global: Multiple Perspectives

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Geography

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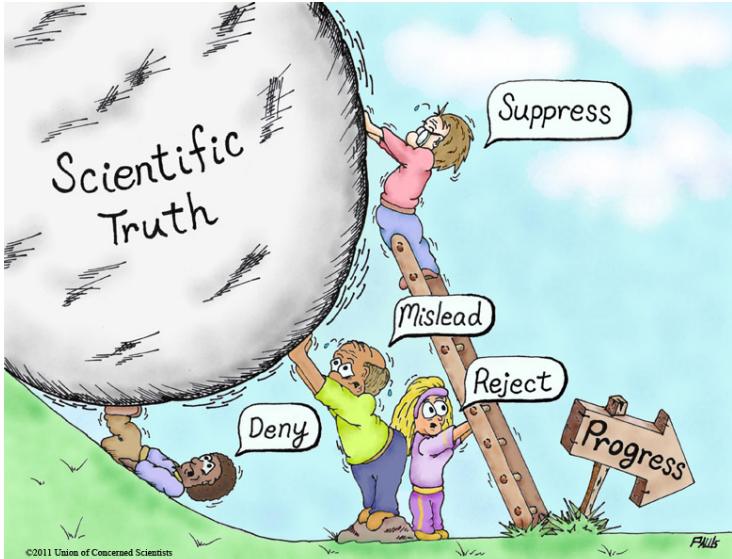
Weather

Still controversial? flat earth society



<http://www.icis.com/blogs/asian-chemical-connections/FlatEarth.jpg>
http://img.dailymail.co.uk/i/pix/2008/04_01/aprilfool60104_468x627.jpg

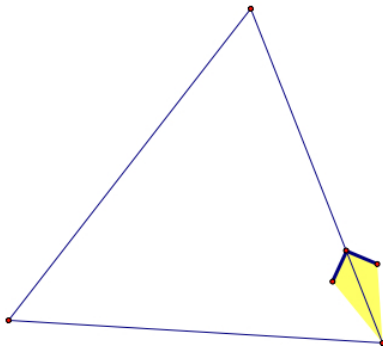
What does a geometric space look like, how do we know, and how do we represent it? Other possibilities and real-world applications...



Geometry Flat Angle Sum = ?

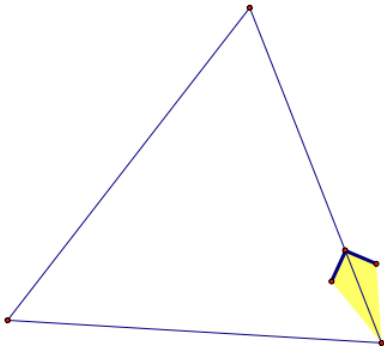
Geometry Flat Angle Sum = ?

Why/How do we know?



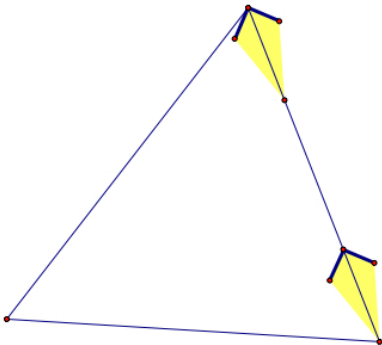
Walking a Euclidean Angle Sum

- Lay out a triangle with masking tape
- Pick a vertex to begin your triangle walk. Note the vertex and which way you are facing.



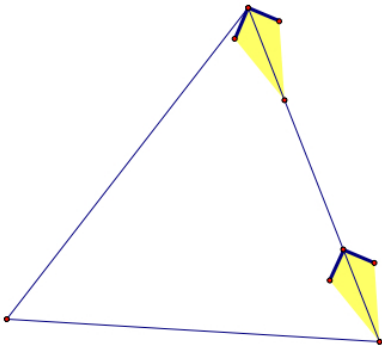
Walking a Euclidean Angle Sum

- Start walking along your triangle, keeping the center of your body on the boundary of the triangle.



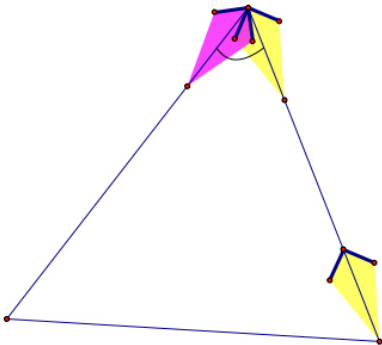
Walking a Euclidean Angle Sum

- When you get to a turn (one of the angles of the triangle), turn your body so that it sweeps the interior angle of the triangle (careful!). You may be walking backwards for a time.



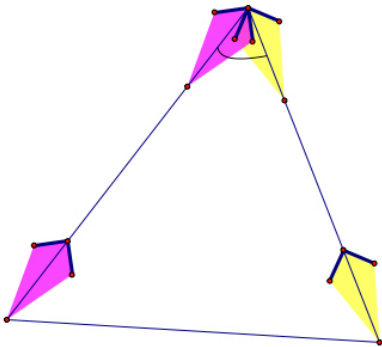
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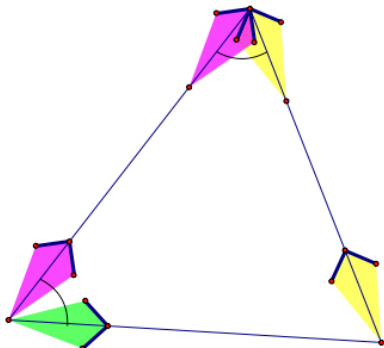
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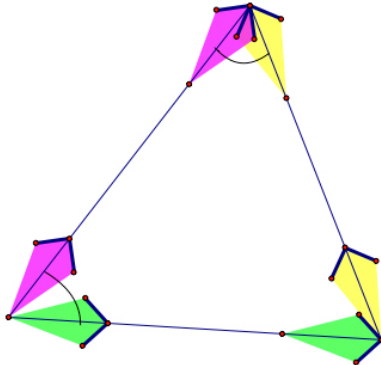
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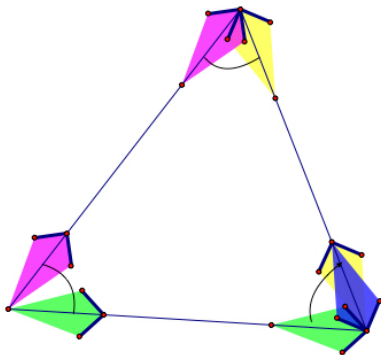
Walking a Euclidean Angle Sum

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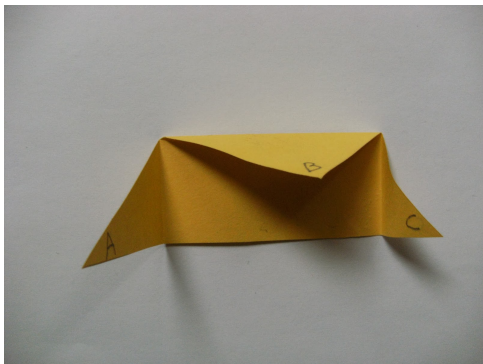
Walking a Euclidean Angle Sum Intrinsically

- Sweep out the last interior angle to finish your angle sum walk.
- The change in direction in your body from start to finish is the sum of the angles in this triangle.



Folding an Angle Sum Extrinsically

- Rip a triangle from paper.
- Fold one angle to bring it down to the base by using a fold parallel to the base.
- Fold the other angles in

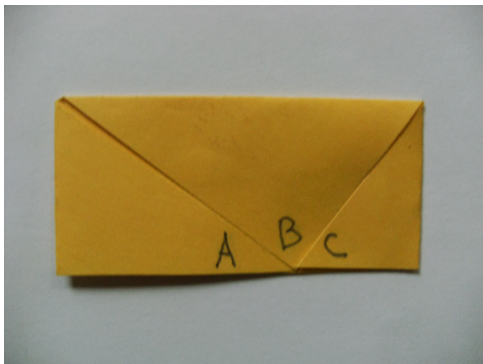


<http://mathonthemckenzie.blogspot.com/2013/12/180.html>



Folding an Angle Sum Extrinsically

- Notice the angles fit to take up the entire space along the base and this gives us the angle sum.

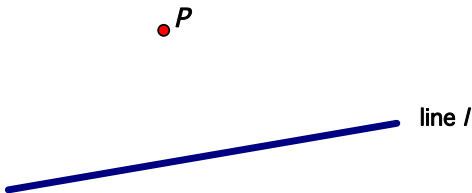


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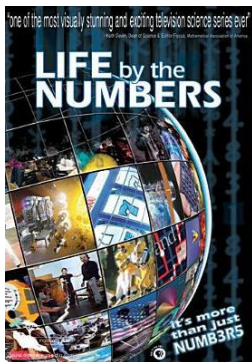
What is Dimension and Parallel?

Dimension: degrees of freedom of movement in space or efficient algebraic coordinates.

Parallel: straight-feeling paths that never meet.



Shape of the World & Seeing is Believing Video



PBS

The people in the video:

American Actor & Director (narrator here): **Danny Glover**

British Artist and Mapmaker: **Nigel Holmes**

American Art Historian: **Sam Edgerton**



Projective Geometry: Artists and Mathematicians

Dimension: degrees of freedom of movement in space or efficient algebraic coordinates.

Parallel: straight-feeling paths that never meet.

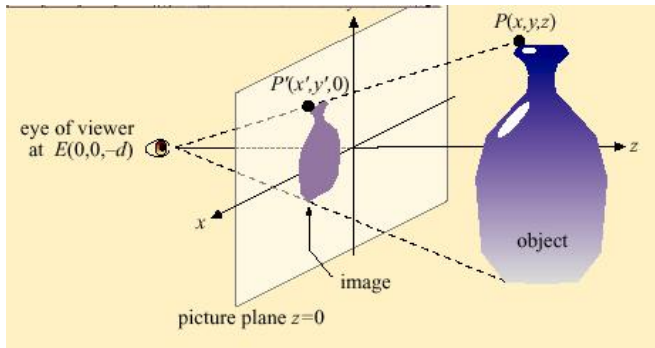
2D Representation of 3D Space



Interior of Antwerp Cathedral, by Pieter Neefs the Elder, 1651

<http://collection.imamuseum.org/artwork/71818/>

Projective Geometry: Artists and Mathematicians



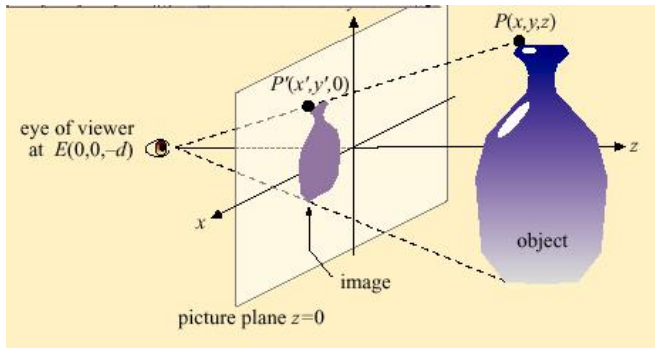
Marc Frantz's Mathematics and Art <https://math.iupui.edu/m290>

$$x' = \frac{dx}{z+d} \quad y' = \frac{dy}{z+d}$$

where d is the distance from the viewer's eye at $(0,0,-d)$

If $d = 3$ and we want to paint the point $(2,4,5)$, we paint at:

Projective Geometry: Artists and Mathematicians



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where d is the distance from the viewer's eye at $(0, 0, -d)$

If $d = 3$ and we want to paint the point $(2, 4, 5)$, we paint at:

$$x' = \frac{3 \times 2}{5+3} \quad y' = \frac{3 \times 4}{5+3}$$



Julian Beever's pavement drawings



<http://www.julianbeever.net/images/phocagallery/gallery/butterfly-i.jpg>

I decided to get into 3D after seeing the effect of tiles being removed from the street, and later trying to recreate the sense of depth in a drawing. Once I realised you could make things go down, I realised you could make them appear to go up and I began experimenting.

Pavement Picasso by Sarah Loat



Julian Beever's pavement drawings



julianbeever.net/images/phocagallery/gallery/thumbs/phoca_thumb_l_globewrongview-i.jpg

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Julian Beever's pavement drawings

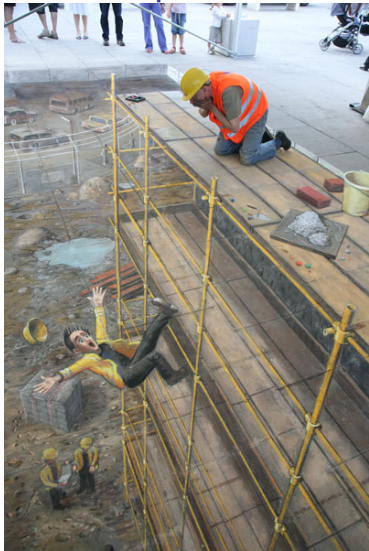


http://www.julianbeever.net/images/phocagallery/gallery/thumbs/phoca_thumb_l_globe-i.jpg

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Julian Beever's pavement drawings



<http://www.julianbeever.net/images/phocagallery/gallery/accident-i.jpg>

Where is North?



https://www.reddit.com/r/Maps/comments/5cogwi/antarctica_the_confusing_continent/

Stand up and point in the direction of North.



<https://mathequalslove.blogspot.com/p/free-classroom-posters.html>

<https://www.leaderinme.org/blog/the-power-of-a-growth-mindset/>

.30 Exams+ **.05** Effective Class Engagement
+ **.50** Effective ASULearn Engagement + **.15** Final Project

Exam Corrections For 1 Exam

- original exam and revisions of one exam toward the end of the semester
- write on exam or separate sheet of paper to correct it
- use resources and get help from me
- Making mistakes is integral to the learning process as long as you review and understand any misconceptions, and I want to encourage and reward this.
- revised exam grade replaces the original. I want you to solidify the material and I am here to help!

