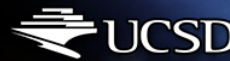


MATH, SCIENCE, AND THE MIND OF GOD

ARTHUR C CLARKE CENTER FOR HUMAN
IMAGINATION



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info@imagination.ucsd.edu
or visit
imagination.ucsd.edu



Center for
Theoretical
Physics

Dr. Andrew Friedman
National Science Foundation
Research Associate, MIT



SPEAKERS



Dr. David Brin
(UCSD)



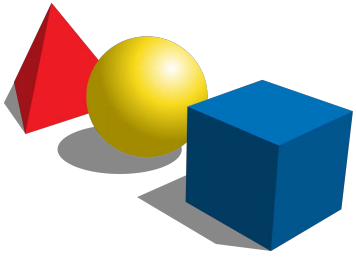
Prof. Brian Keating
(UCSD)



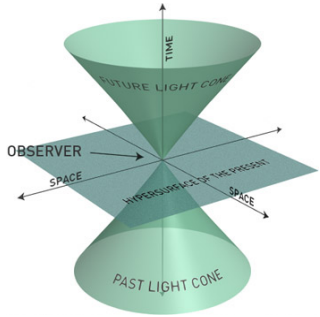
Dr. Andrew Friedman
(MIT)



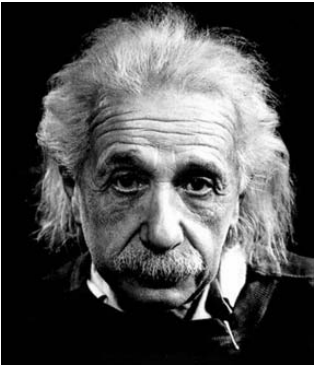
OUTLINE



Math: True in **Any World**



Science: True in **Our World**

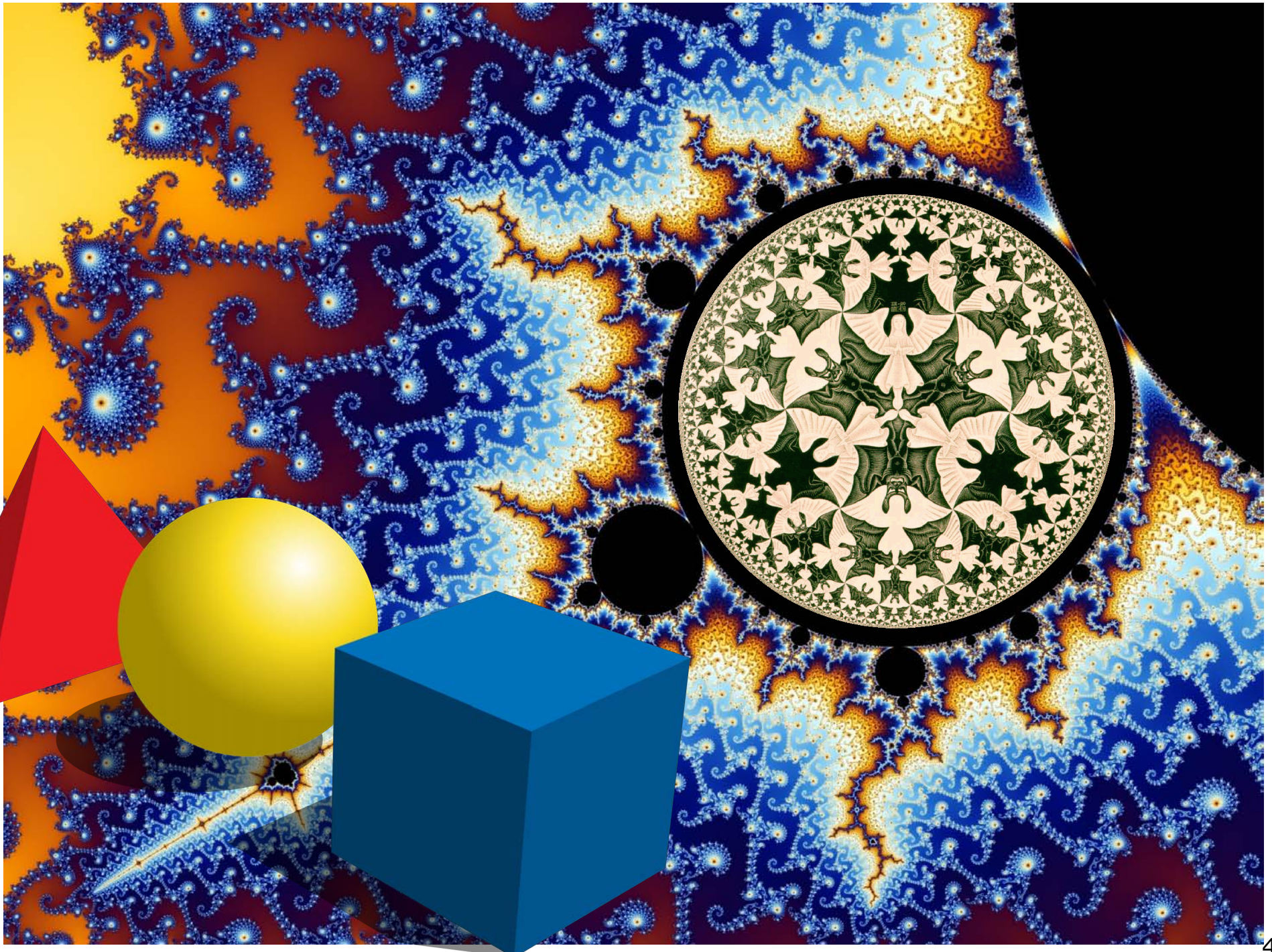


Science and **Spirituality**

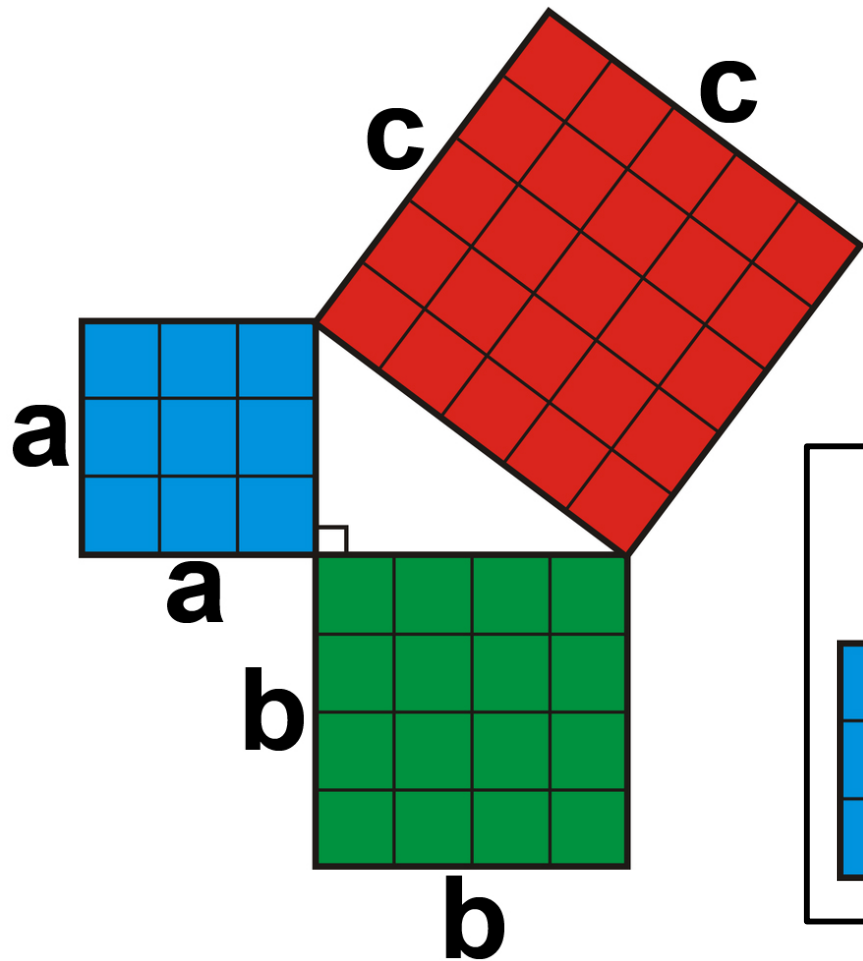


The Mind of **God**

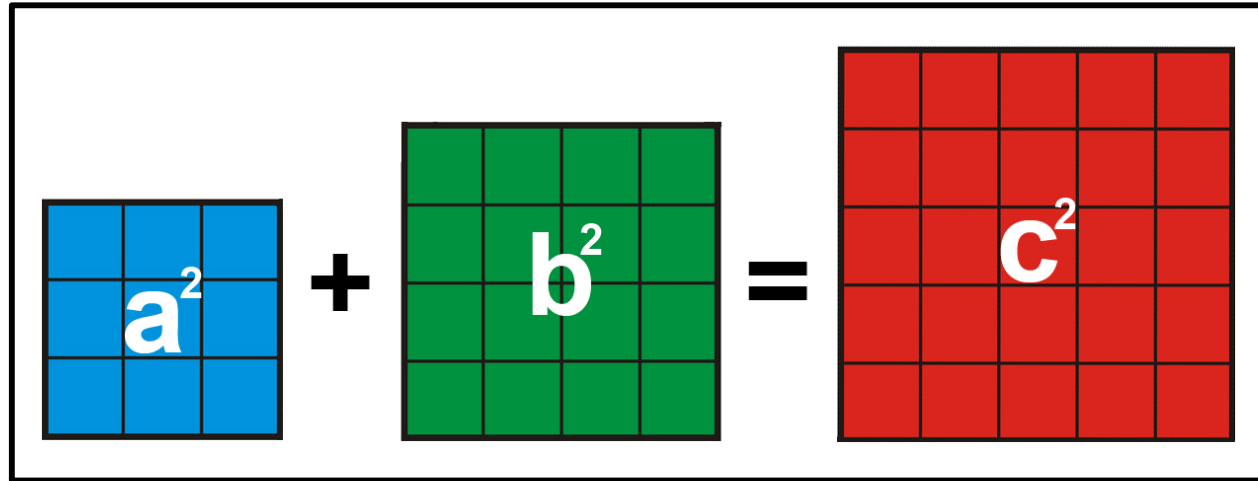
MATH: INVENTED OR DISCOVERED?



WHAT IS MATHEMATICAL TRUTH?



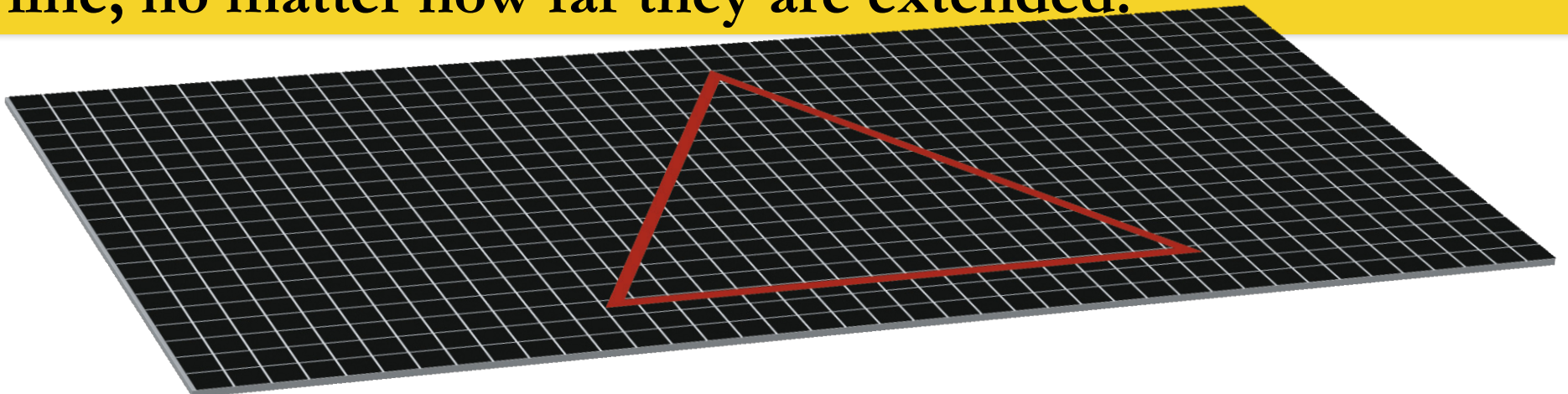
Is $1+1=2$ always
TRUE?



Is the Pythagorean
theorem always **TRUE?**

AXIOMS OF EUCLIDEAN GEOMETRY

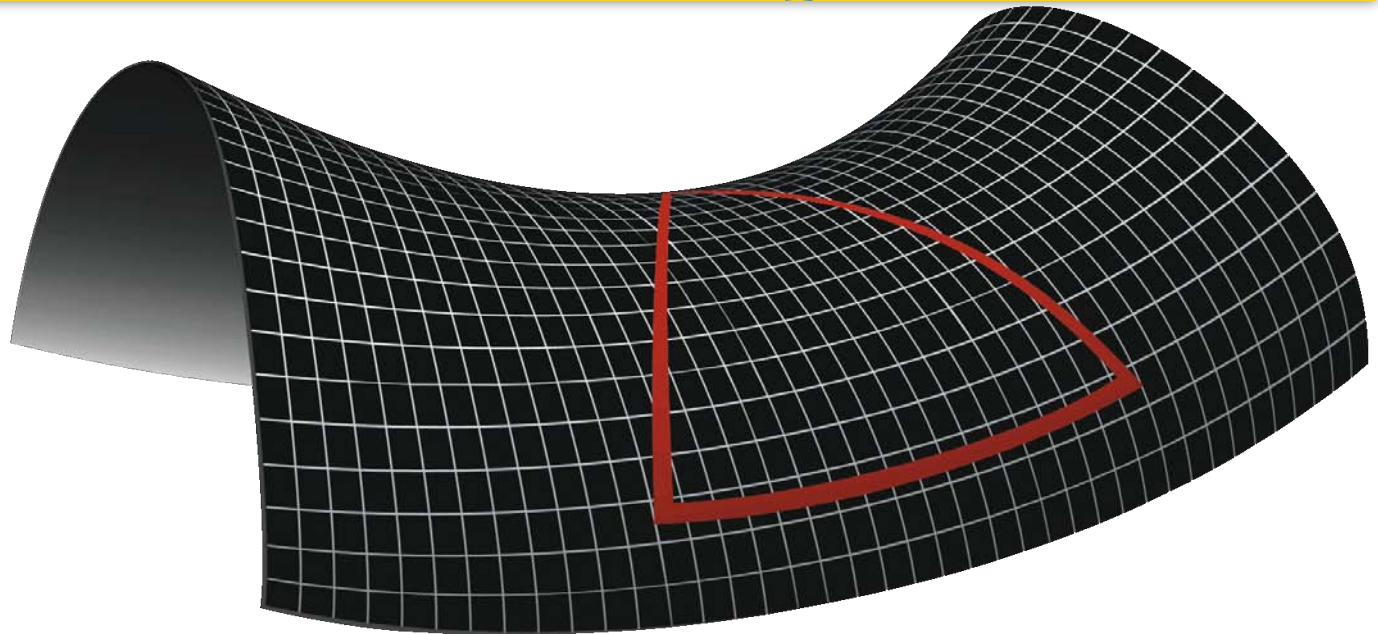
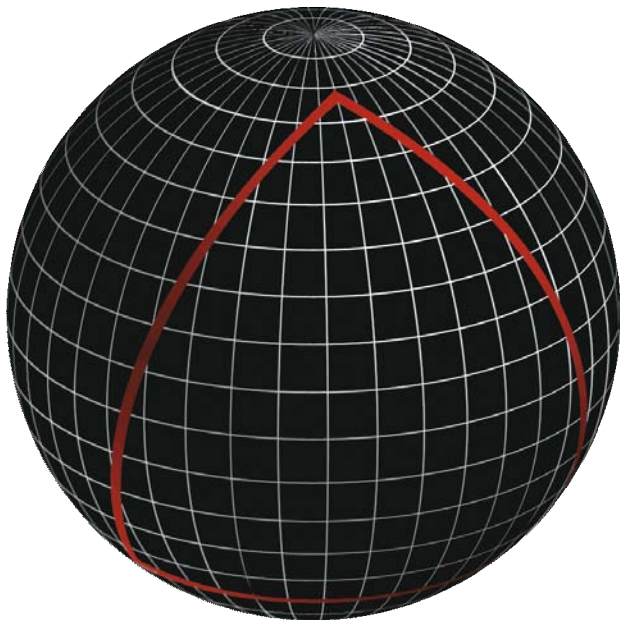
1. You can draw a straight line between any two points.
2. Straight lines can be extended forever in both directions.
3. Given any straight **line segment**, a **circle** can be drawn having the segment as **radius** and one endpoint as center.
4. All **right angles** are **congruent**.
5. **parallel postulate**. Given any straight line and a point not on it, there "exists one and only one straight line which passes" through that point and never **intersects** the first line, no matter how far they are extended.



NON-EUCLIDEAN GEOMETRY

1. You can draw a straight line between any two points.
2. Straight lines can be extended forever in both directions.
3. Given any straight **line segment**, a **circle** can be drawn having the segment as **radius** and one endpoint as center.
4. All **right angles** are **congruent**.

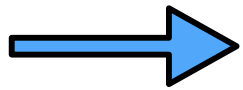
5. ~~parallel postulate~~ → **Curved Space!**



CONDITIONAL MATHEMATICAL TRUTH

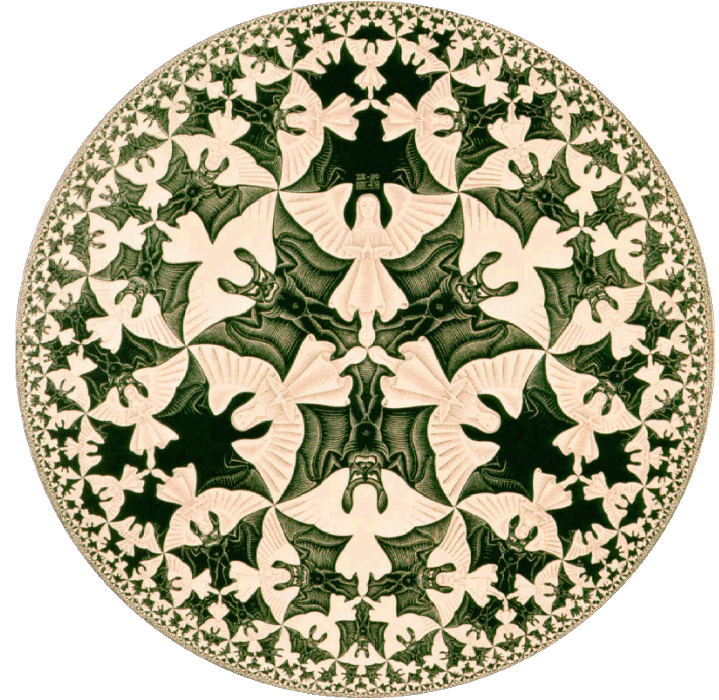
If axioms \longrightarrow then theorems

If no
“parallel”
postulate



spherical geometry

or



hyperbolic geometry

True whether we like it or not.

Not even God could change this!

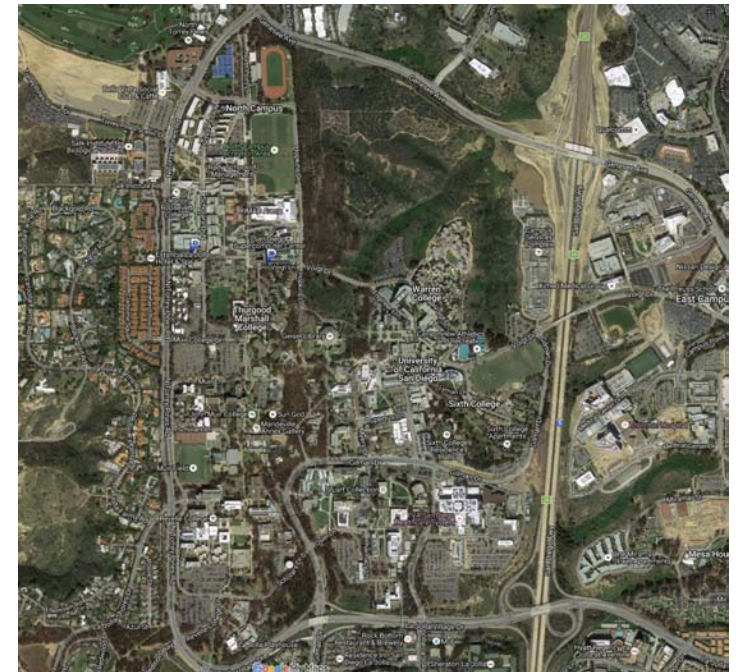
MAP VS. TERRITORY

$$p_G(\lambda|x, y) = \frac{w}{4\pi} \left(\frac{1 + \cos \alpha \operatorname{sign} [\cos \phi_\lambda \cos(\phi_\lambda - \alpha)]}{1 + (1 - 2\alpha/\pi) \operatorname{sign} [\cos \phi_\lambda \cos(\phi_\lambda - \alpha)]} \right) + (1 - w) \frac{|\sin \theta_\lambda \cos \phi_\lambda|}{2\pi}$$

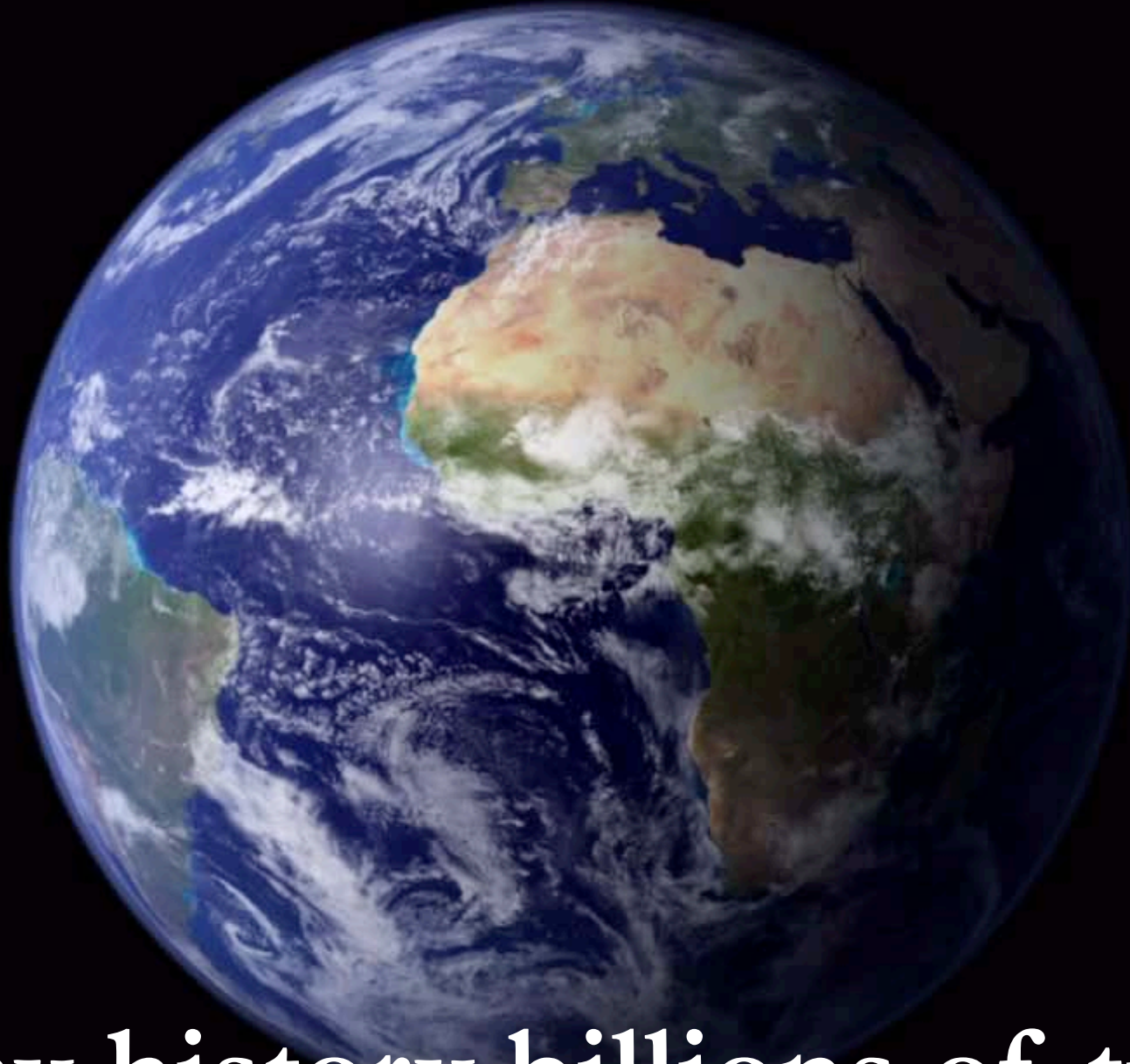
$$p_G(\lambda|x', y) = \frac{w}{4\pi} \left(\frac{1 + \cos(\beta - \alpha) \operatorname{sign} [\cos(\phi_\lambda - \beta) \cos(\phi_\lambda - \alpha)]}{1 + (1 - 2(\phi_{\beta\alpha})/\pi) \operatorname{sign} [\cos(\phi_\lambda - \beta) \cos(\phi_\lambda - \alpha)]} \right) + (1 - w) \frac{|\sin \theta_\lambda \cos(\phi_\lambda - \beta)|}{2\pi}$$

$$p_G(\lambda|x, y') = \frac{w}{4\pi} \left(\frac{1 + \cos \gamma \operatorname{sign} [\cos \phi_\lambda \cos(\phi_\lambda - \gamma)]}{1 + (1 - 2\gamma/\pi) \operatorname{sign} [\cos \phi_\lambda \cos(\phi_\lambda - \gamma)]} \right) + (1 - w) \frac{|\sin \theta_\lambda \cos \phi_\lambda|}{2\pi}$$

$$p_G(\lambda|x', y') = \frac{w}{4\pi} \left(\frac{1 + \cos(\beta - \gamma) \operatorname{sign} [\cos(\phi_\lambda - \beta) \cos(\phi_\lambda - \gamma)]}{1 + (1 - 2(\phi_{\beta\gamma})/\pi) \operatorname{sign} [\cos(\phi_\lambda - \beta) \cos(\phi_\lambda - \gamma)]} \right) + (1 - w) \frac{|\sin \theta_\lambda \cos(\phi_\lambda - \beta)|}{2\pi}$$

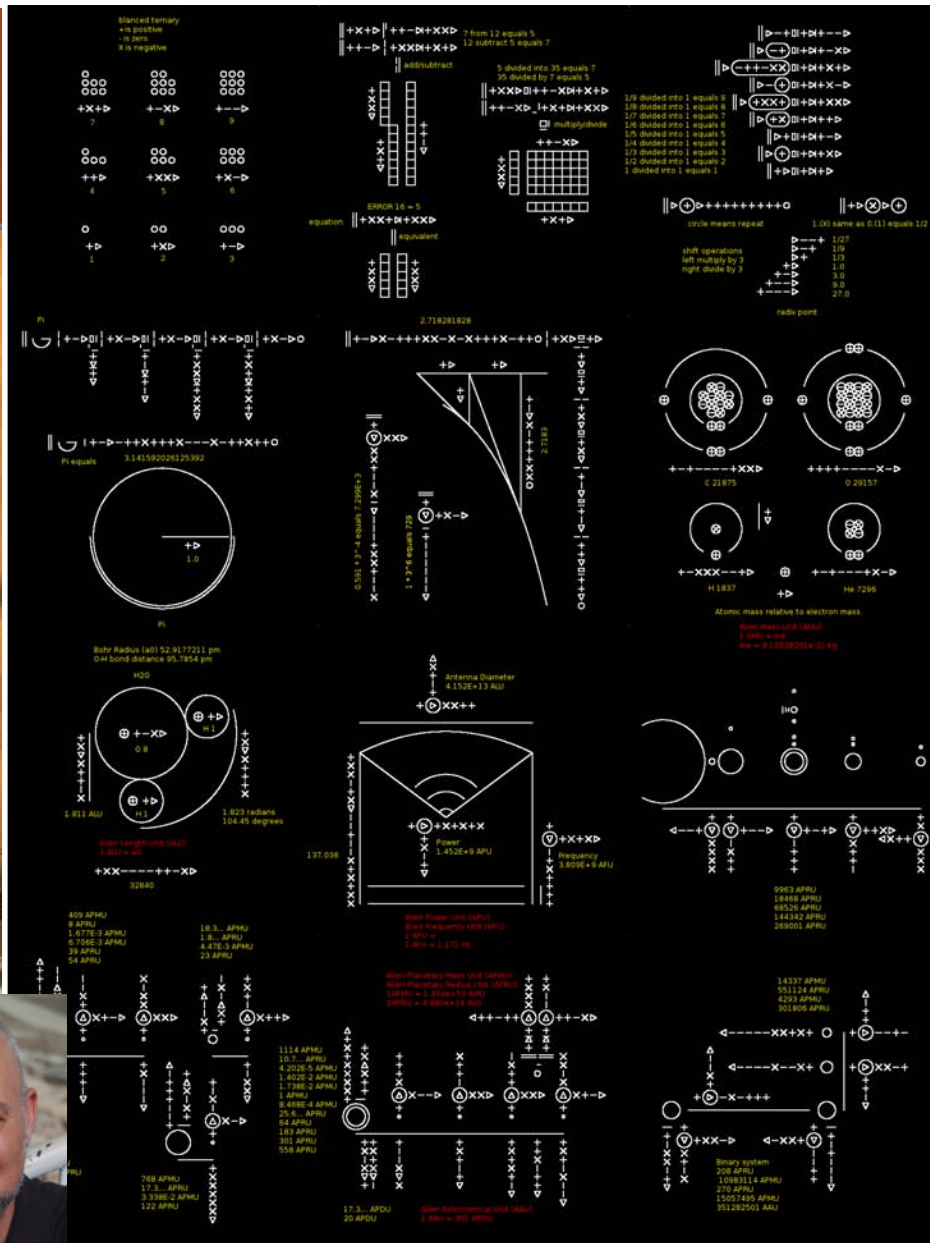
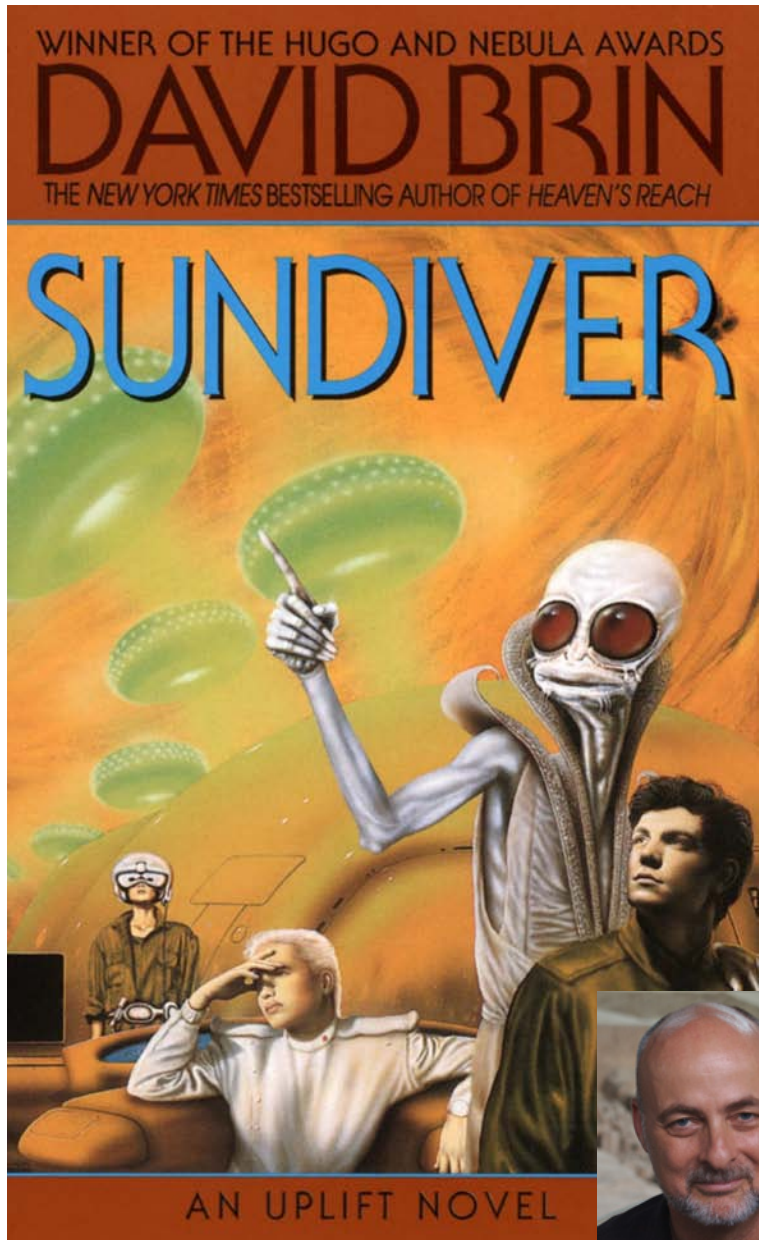


TESTING IF MATH IS DISCOVERED



Replay history billions of times!

TESTING IF MATH IS DISCOVERED



Meet aliens! See what they've found.

<http://i18.picdn.net/shutterstock/videos/3030901/thumb/1.jpg>

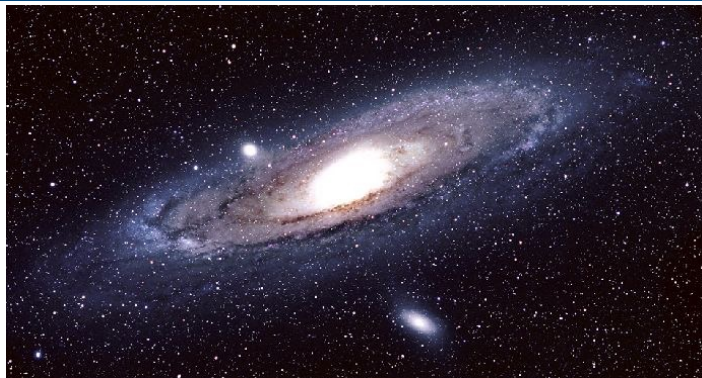
<https://s-media-cache-ak0.pinning.com/736x/fe/9d/52/fe9d524c365c410f711c6e7679a3dc25.jpg>

WHY IS MATH SO GOOD AT SCIENCE?

“The unreasonable effectiveness of mathematics in the natural sciences”
-Eugene Wigner, 1960

“The most incomprehensible thing about the universe is that it is comprehensible” -Albert Einstein, 1936

http://www.nasa.gov/sites/default/files/1-blumarble_west.jpg http://casswww.ucsd.edu/archive/public/images/m31_jg.jpg <https://whatsonmyblackboard.files.wordpress.com/2012/07/josejuly2012.jpg>
<http://static1.squarespace.com/static/51951fd3e4b0566afb246df5/t/51953608e4b0ed5331de3d8a/1368733194520/smd-thumb-astrophysics-685x685.jpg>



SCIENTIFIC TRUTH

Empirical Testing

Question assumptions. Develop models. Make risky predictions. Do careful experiments.

Explanation and Interpretation

Find which mathematical models best explain the world. Give meaning to the mathematics.

Error Correction

Be aware of your own biases. Correct for them!

Humility and Open Mindedness

Parametrize our Ignorance. No perfect certainty. No Dogma. Knowledge is always provisional. Keep updating your beliefs based on new evidence.

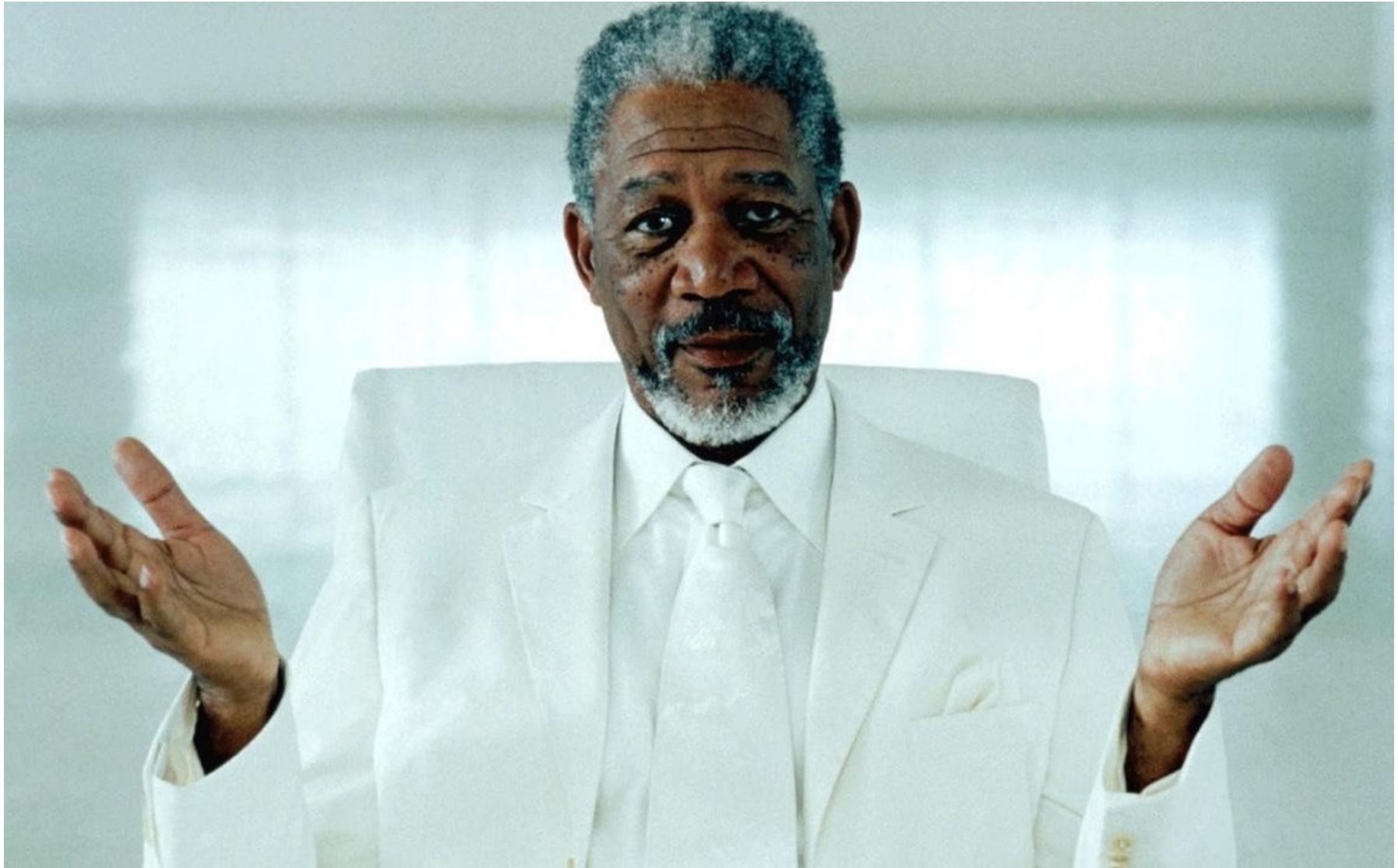
THE MIND OF GOD



[https://upload.wikimedia.org/wikipedia/commons/7/7f/Comets_Kick_up_Dust_in_Helix_Nebula_\(PIA09178\).jpg](https://upload.wikimedia.org/wikipedia/commons/7/7f/Comets_Kick_up_Dust_in_Helix_Nebula_(PIA09178).jpg)
<http://xeon24.com/data/wallpapers/2/508769-albert-einstein.jpg>

“I want to know how God created this world...I want to know His thoughts, the rest are details.”

DO YOU BELIEVE IN GOD?



http://www.telegraph.co.uk/content/dam/films/2016/04/25/morgan-freeman-god-CULTURE-xlarge_trans++Rp36Ti1MFCYr8PMuS2fHb17hoDUspm84EYI8tHPMRik.jpg

Not a YES or NO question!

All the complexity gets hidden in the definition.

INADEQUACY OF RELIGIOUS LABELS



JEDI?

<http://pad2.whstatic.com/images/thumb/0/0a/Understand-the-Difference-Between-Theism-and-Atheism-Step-1.jpg/aid21222-728px-Understand-the-Difference-Between-Theism-and-Atheism-Step-1.jpg>
http://vignette2.wikia.nocookie.net/starwars/images/d/d6/Yoda_SWSB.png/revision/latest?cb=20150206140125

Struggler, skeptic, seeker, humanist, scientist?

GOD IS NOT A PERSON



AVOIDING A STERILE DEFINITION

Pantheism:

The view that everything is part of an all-encompassing immanent abstract God; or that the universe, or nature, and God are equivalent. <https://en.wikiquote.org/wiki/Pantheism>

Not Good Enough

God=the universe

God=the laws of physics

God=mathematical truth

What's Missing:

Life!

A POSSIBLE DEFINITION OF GOD

God is the collective knowledge and meaning created by all conscious beings in history of the universe.

God is an imperfect, continually evolving, open-ended process in the natural world.

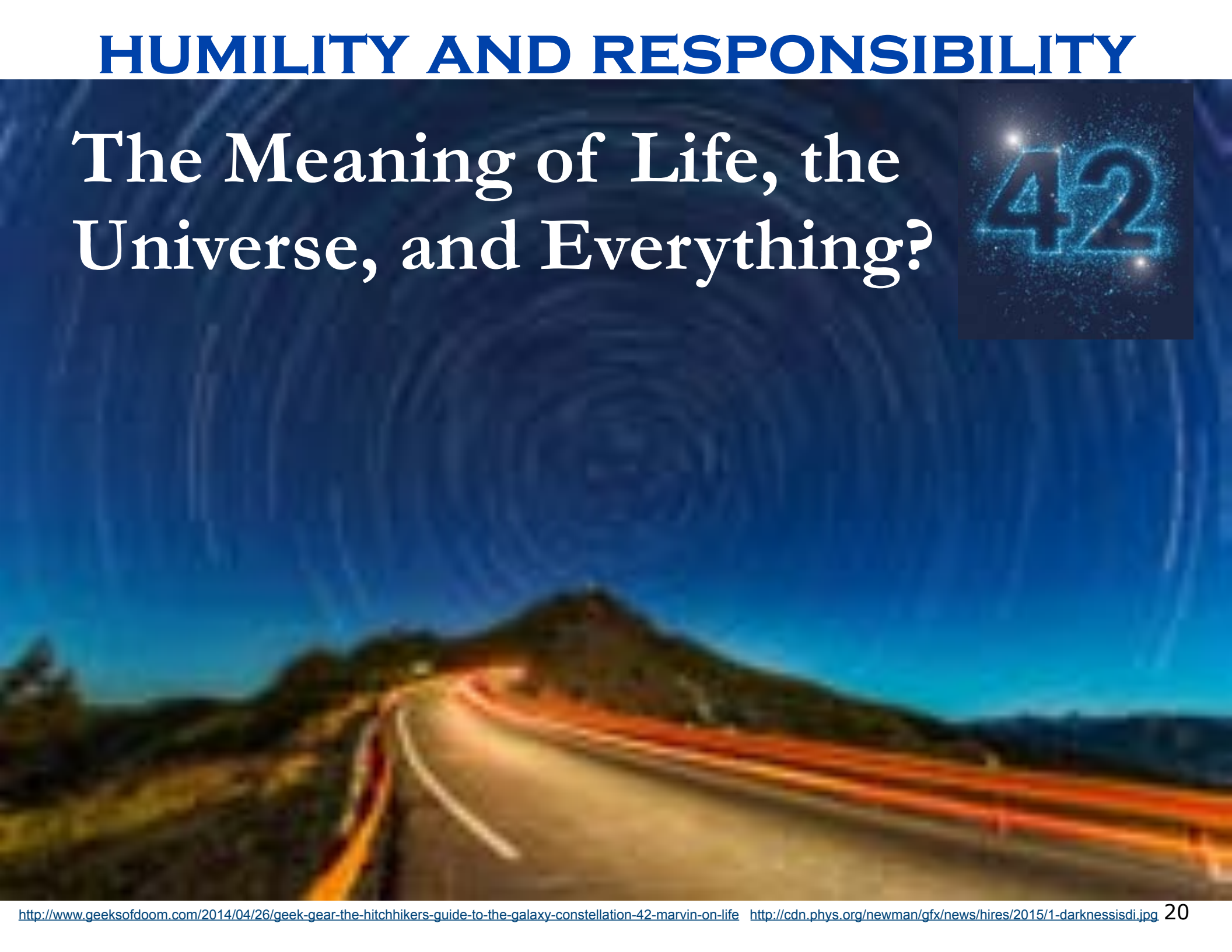
The “Mind of God” is comprehensible by us.

But God is NOT A PERSON!

Personhood only applies to living beings.

HUMILITY AND RESPONSIBILITY

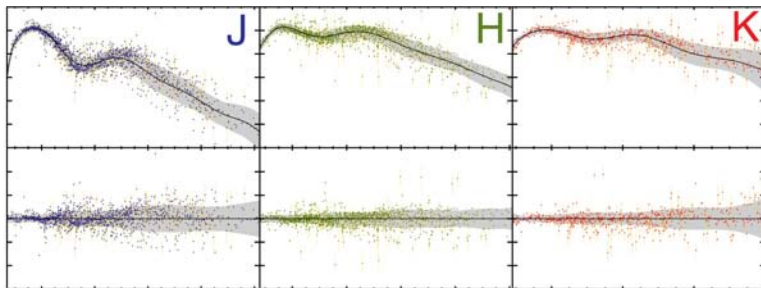
The Meaning of Life, the Universe, and Everything?



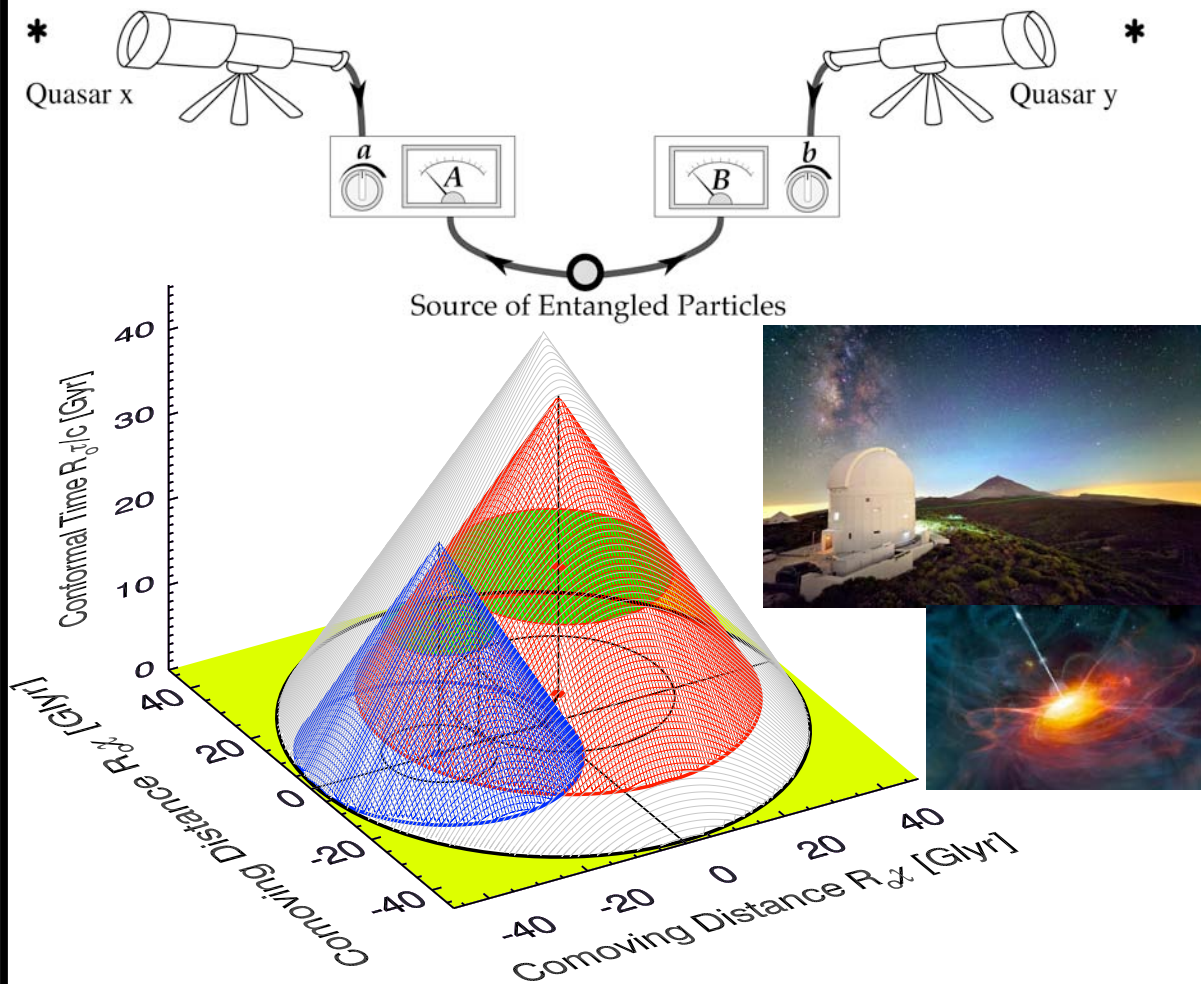
SCIENCE AND SPIRITUALITY



http://apod.nasa.gov/apod/image/1505/sn94d_hiZ_2608.jpg



Supernova Cosmology



Cosmological Tests of Quantum Mechanics

The epitome of spirituality, for me, is doing science!

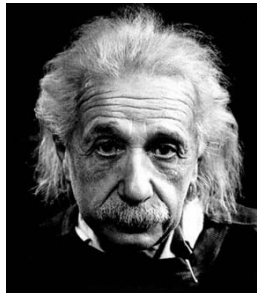
CONCLUSIONS



“Knowledge” part of God is objective.
Out there to be discovered.
Mathematical and scientific truth.



“Meaning of life” part of God is subjective.
Only we can invent and create it.

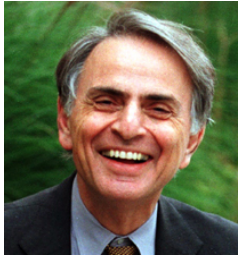


The universe is comprehensible by us.
If it wasn't, we wouldn't be here.



Everyone must undergo their own struggle.
Spiritual beliefs are our personal responsibility.

CONCLUSIONS



Carl Sagan: “We are the eyes and ears of the cosmos”. The means by which an unconscious universe can come to understand itself.



The cosmos was not created for us by a God that exists outside the universe.
Nor are we the “center” of the universe.



But the Copernican principle goes too far.
Conscious beings **ARE** critically important in the cosmic scheme.



Without us, nothing in the universe would matter.
Without us, “the Mind of God” could never exist.

NEXT TALKS



**Prof. Brian Keating
(UCSD)**

**The origin
of Time in
the universe**



https://upload.wikimedia.org/wikipedia/commons/a/ad/Astronomical_Clock,_Prague.jpg



**Dr. David Brin
(UCSD)**

**Science,
Religion,
and the Big
Questions.**



<http://www.rawstory.com/wp-content/uploads/2015/10/AngryGod-800x430.jpg>

REFERENCES

Albert Einstein, from “Physics and Reality” (1936), in *Ideas and Opinions*, trans. Sonja Bargmann (New York: Bonanza, 1954), p. 292.

Albert Einstein, Quoted in Timothy Ferris, “Coming of Age in the Milky Way”, (New York, Morrow, 1988), p. 177.

Carl Sagan, “Pale Blue Dot: A Vision of the Human Future in Space”, Random House (1994) p. 77.

Carl Sagan, “Cosmos”, Random House, (1980), 396 pp (2013 edition)

Sean Carroll, “The Big Picture: On the Origins of Life, Meaning, and the Universe Itself”, Dutton (2016), 480 pp

Eugene Wigner, “The Unreasonable Effectiveness of Mathematics in the Natural Sciences,” in *Communications in Pure and Applied Mathematics*, vol. 13, No. I (February 1960). New York: John Wiley & Sons, Inc. 25

INDEPENDENT MATH DISCOVERY

Logarithms – John Napier (Scotland, 1614) and Joost Bürgi (Switzerland, 1618).

Analytic geometry – René Descartes, Pierre de Fermat.

Problem of points solved by both Pierre de Fermat (France, 1654), Blaise Pascal (France, 1654), and Huygens (Holland, 1657).

Determinants – Gottfried Wilhelm Leibniz and Seki Kōwa.

Calculus – Isaac Newton, Gottfried Wilhelm Leibniz, Pierre de Fermat and others.^[22]

Newton–Raphson method – Joseph Raphson (1690), Isaac Newton (Newton's work was written in 1671, but not published until 1736).

Brachistochrone problem solved by Johann Bernoulli, Jakob Bernoulli, Isaac Newton, Gottfried Wilhelm Leibniz, Guillaume de l'Hôpital, and Ehrenfried Walther von Tschirnhaus. The problem was posed in 1696 by Johann Bernoulli, and its solutions were published next year.

Complex plane – Geometrical representation of complex numbers was discovered independently by Caspar Wessel (1799), Jean-Robert Argand (1806), John Warren (1828), and Carl Friedrich Gauss (1831).^[28]

Non-Euclidean geometry (hyperbolic geometry) – Nikolai Ivanovich Lobachevsky (1830), János Bolyai (1832); preceded by Gauss (unpublished result) ca. 1805.

The list goes on and on....