
ASA Annual Meeting 2009
July 31-August 3, 2009
Believing in Everything?
Exploring God's World of Endless Wonder
or
Exploring the Wonder of God's Endless World?
The Canadian Scientific and Christian Affiliation

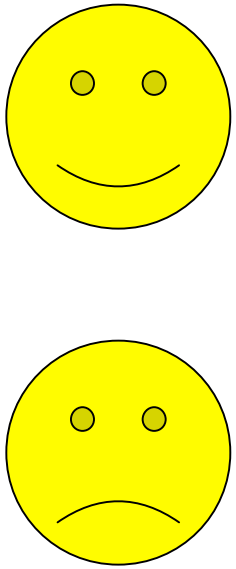
Anything and Everything

A theory of everything* is not the same as a theory of anything†

A God who can do anything* is not the same as a god that does everything†

Anything and Everything

A theory of everything* is not the same as a theory of anything¥



A God who can do anything* is not the same as a god that does everything¥

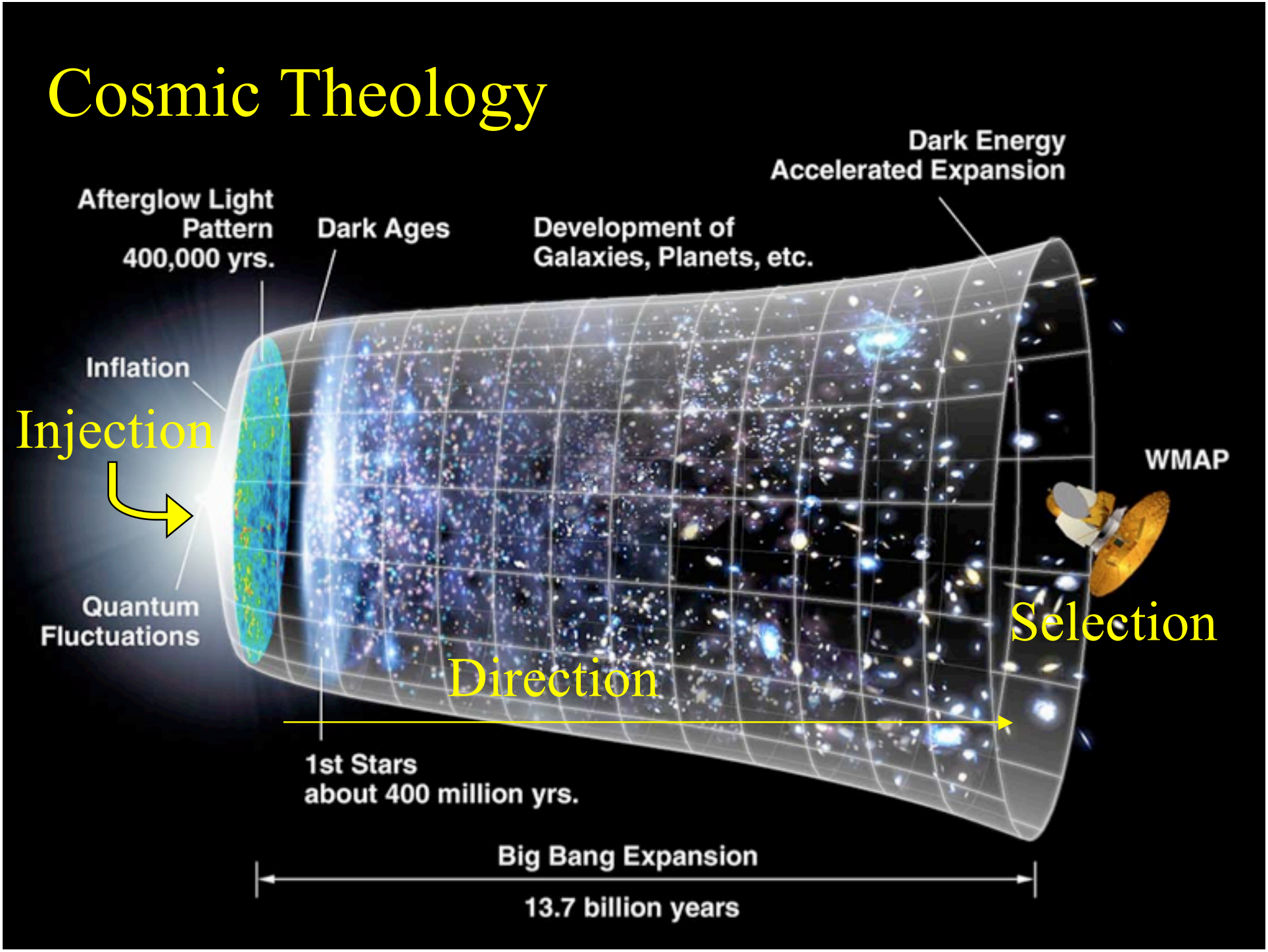
*A (reductionist) description of all that physically does and might exist

¥ A (reductionist) assertion that all that might exist does physically exist

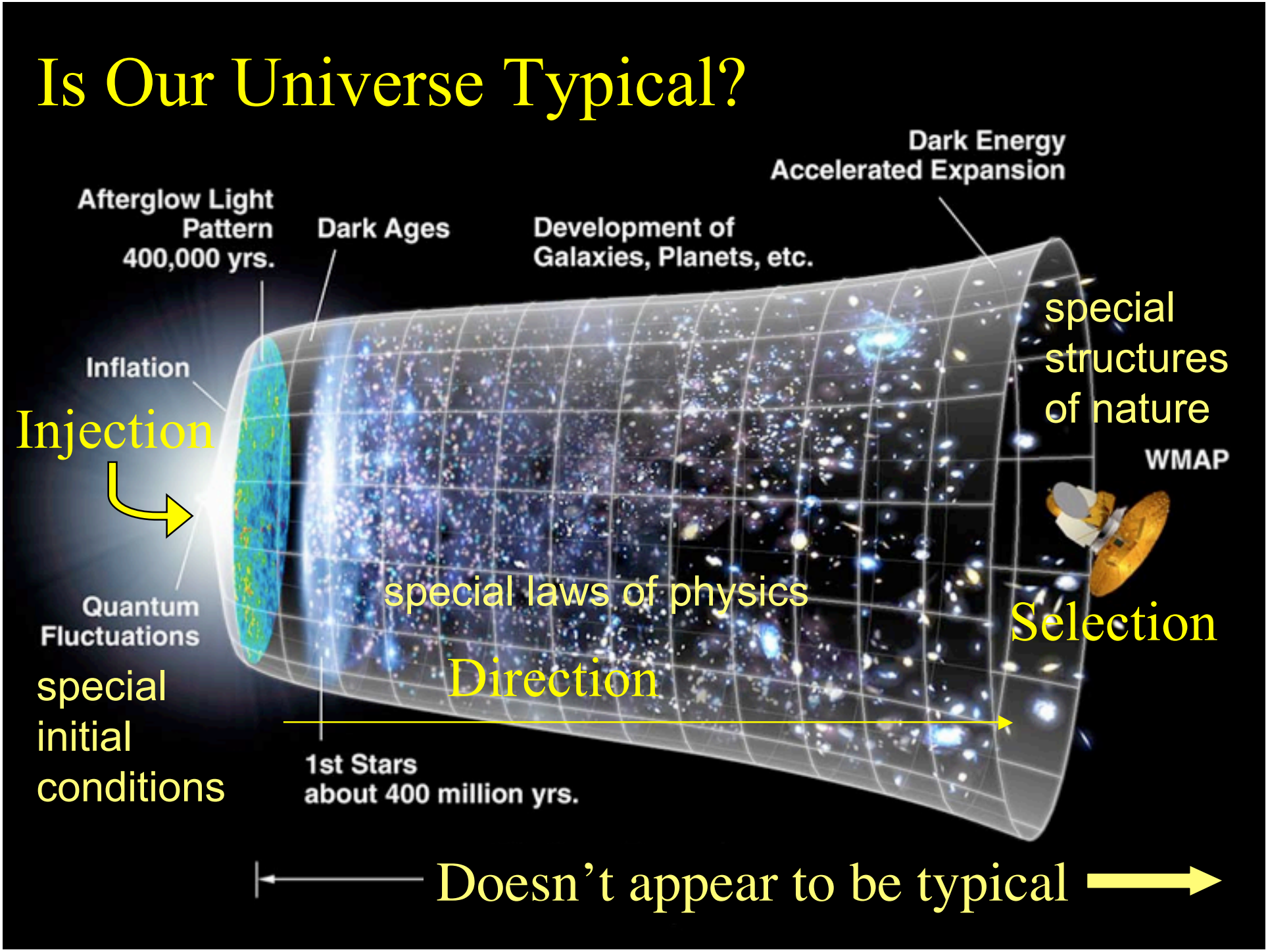
*A creator capable of instantiating any self-consistent reality

¥ An agent that instantiates all possible self-consistent realities

Cosmic Theology



Is Our Universe Typical?



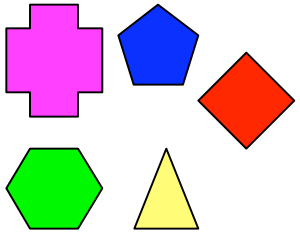
Anthropic Accolade

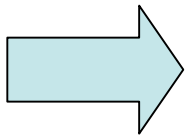
- We can only live in a universe whose
  - Laws (constants of nature) permit our kind of life
  - Structure (planets, water) permits our kind of life
  - Initial conditions (entropy, expansion) allowed our kind of life
  - Obvious when you think about it
- Life needs SPECIAL PERMISSION
  - Laws, structure and initial conditions are all **special**
  - Biophilic parameter range is NARROW, not broad
  - Not obvious -- discovered over the last 50 years
- Out of all possible universes, ours is NOT TYPICAL

The Puzzle of Potentiality

Standard Paradigm

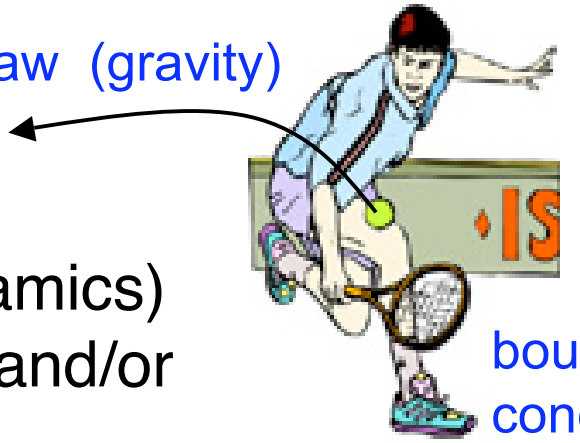
- Many potentialities





- One actuality

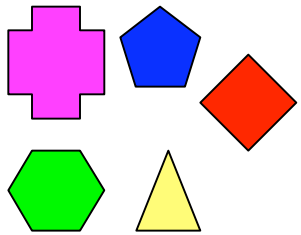
- Physics describes (a) the actual system and (b) the possible things a system can do
- Does NOT mean that all the possible things are actual (materially) existing things/events



What is actualized depends on
a) underlying laws (symmetries, dynamics)
b) boundary conditions (set by agent and/or environment)

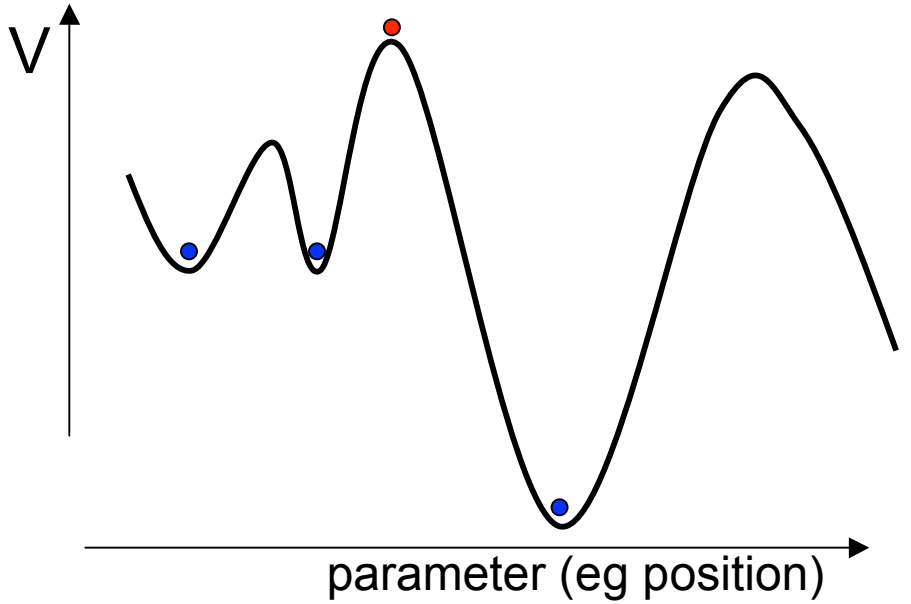
From the Potential to the Actual

- Many potentialities

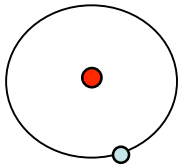


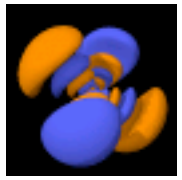
- One actuality

- Systems seek out
  - lowest energy
  - largest entropy
  - maximal stability



Hydrogen Atom





$n = 1$ $\ell = 0$ $m = 0$

$n = 2$ $\ell = 1$ $m = 0$

$n = 7$ $\ell = 2$ $m = 1$

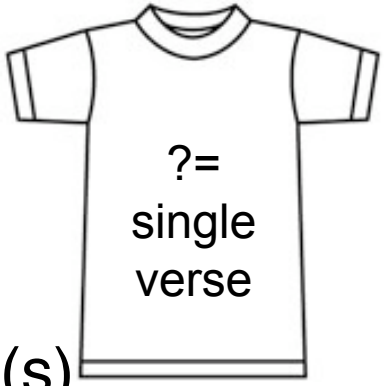
- Crucial role of agency is tacitly ignored
- Agency used as needed
  - a) In setting up experiments
  - b) In making observations
  - c) In applying the science

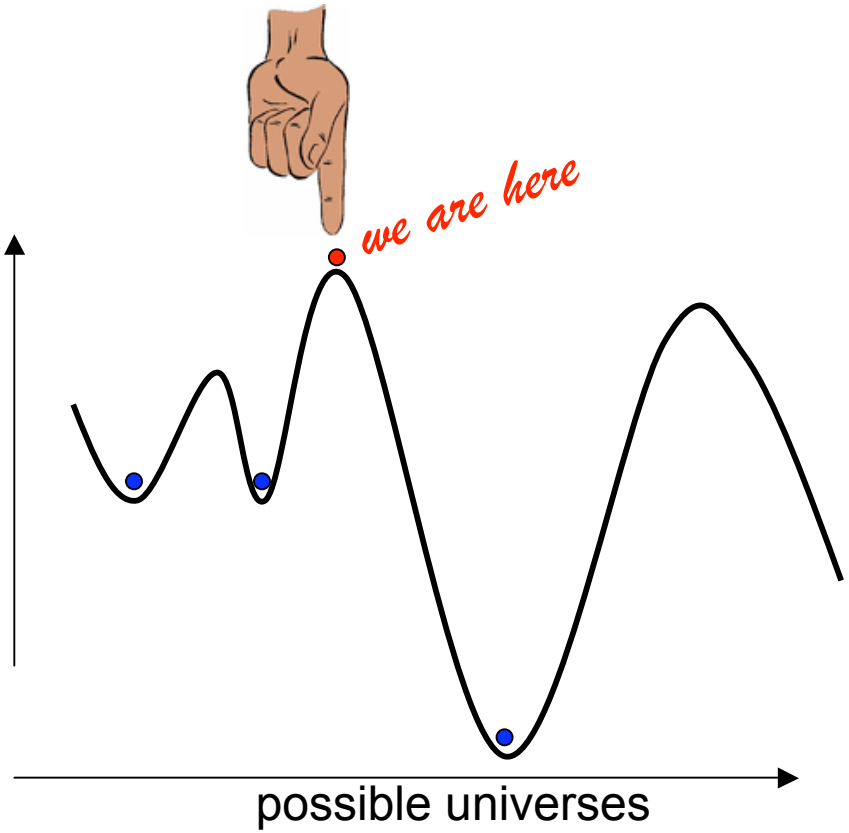
D. Manthey http://www.orbitals.com/orb/ov.htm

Cosmological Actuality

Role of special conditions?

~~Arbitrary without reason?~~



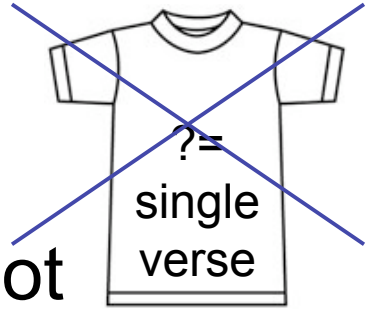


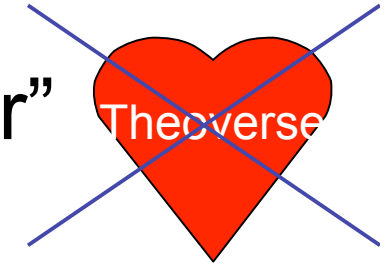
- Result of Natural Law(s)
  - governing dynamical evolution?
  - determining initial conditions?

- Result of Agency?
  - causal link between intention and action?

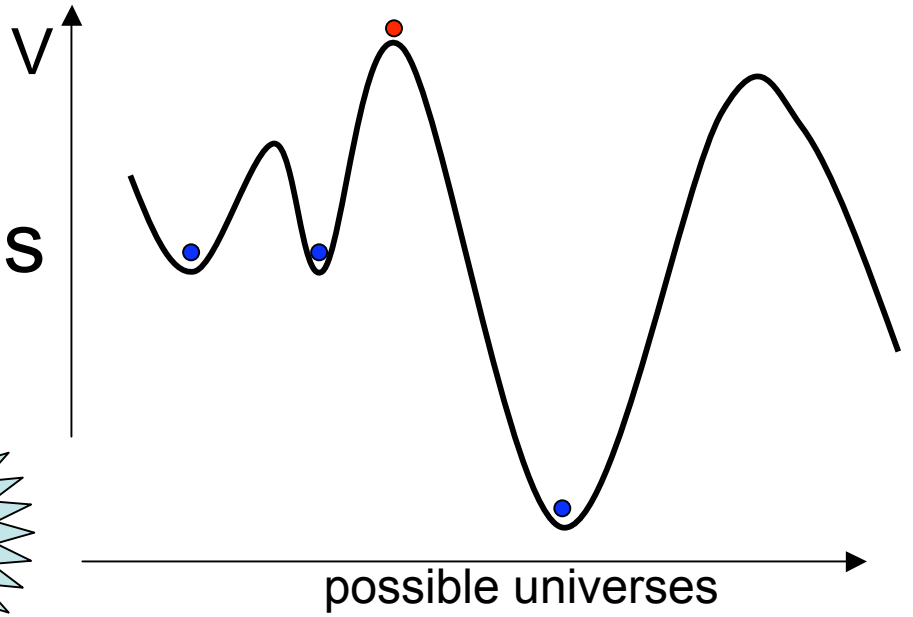
- Result of Statistics?
  - inevitable due to all possibilities being actualized?
  - typical within observer-permitting universes?

Why a Multiverse?





- Frustration with Standard Science
  - Natural law, symmetry, dynamics are not working as hoped
- Agency viewed as a “science stopper”
- Bottom-Up Evidence
  - Cosmic Fine tuning
  - Biophilic Selection
- Top-Down Mechanisms
  - Cosmic Inflation
  - String Theory



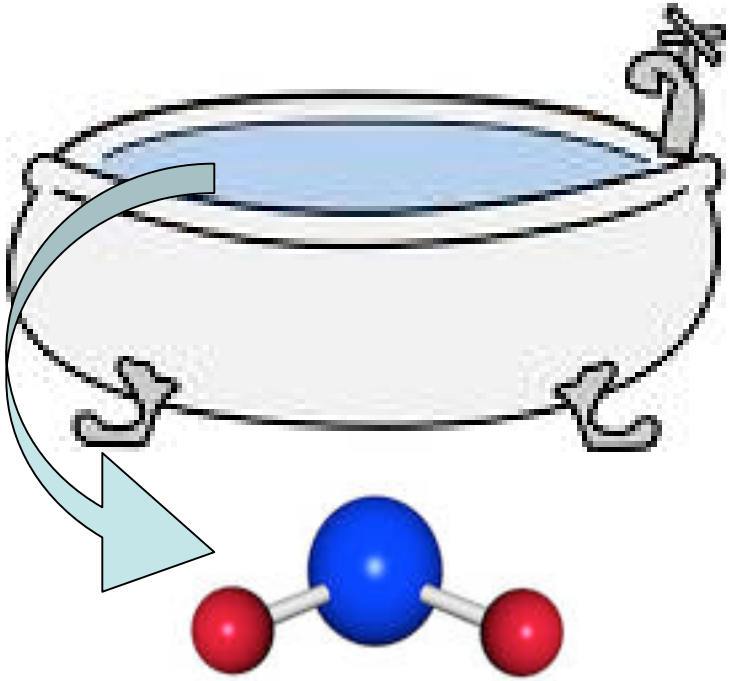
Does Everything Exist?

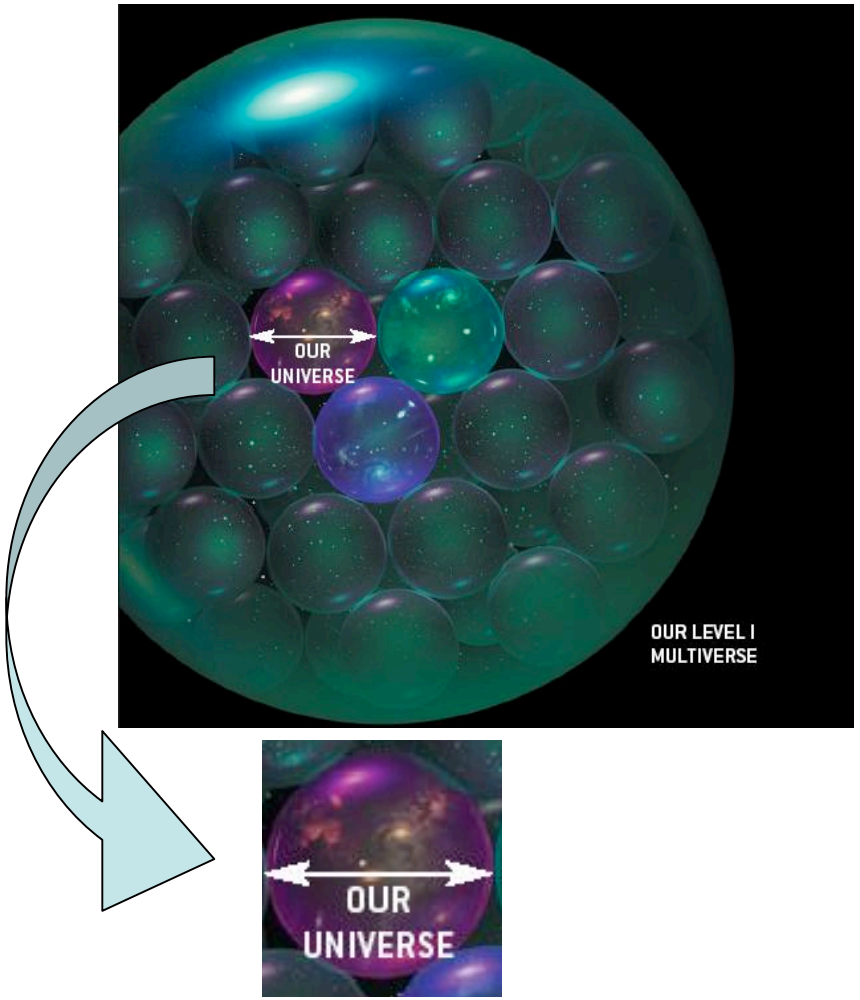
Warning!
Everything means
EVERYTHING!
….doesn't it?

Science in the Multiverse

- Framework
  - What principles guide its construction?
- Counting
  - What counts as a universe? How are universes counted?
- Typicality
  - What is a typical universe? How and why?

What's the Framework?



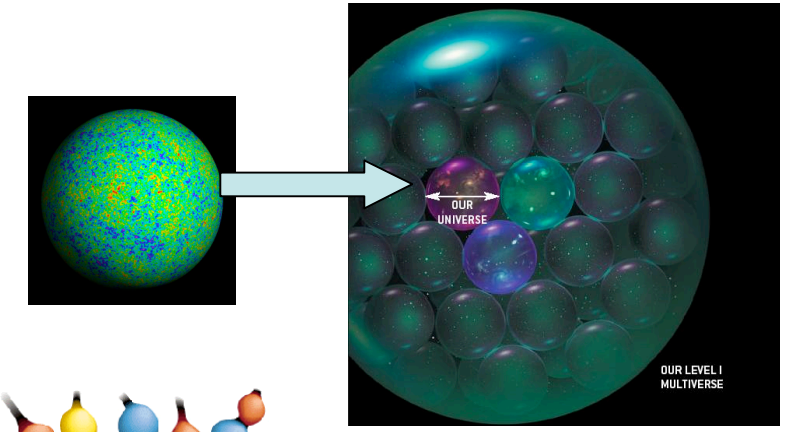


- All allowed properties of liquid water molecules realized
- Randomly selected molecule should exhibit typical properties

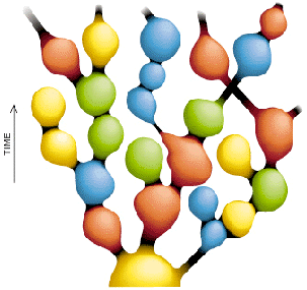
- All allowed properties of universes realized
- Randomly selected universe should exhibit typical properties

5 Levels of Multiverse

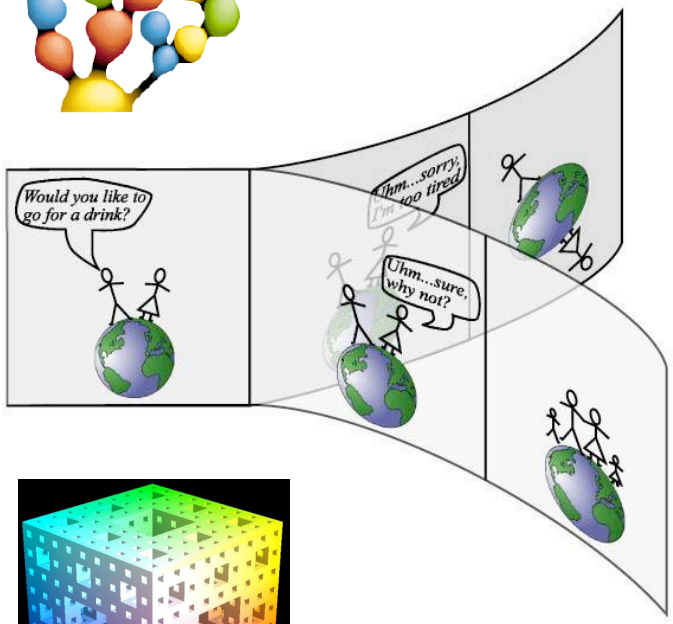
Level 1: All possible initial conditions (inflation)



Level 2: All possible laws of physics (string theory)

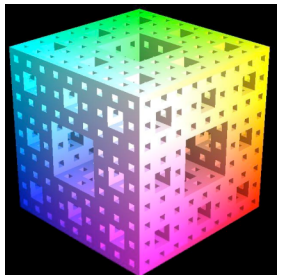


Level 3: All possible outcomes (quantum mechanics)



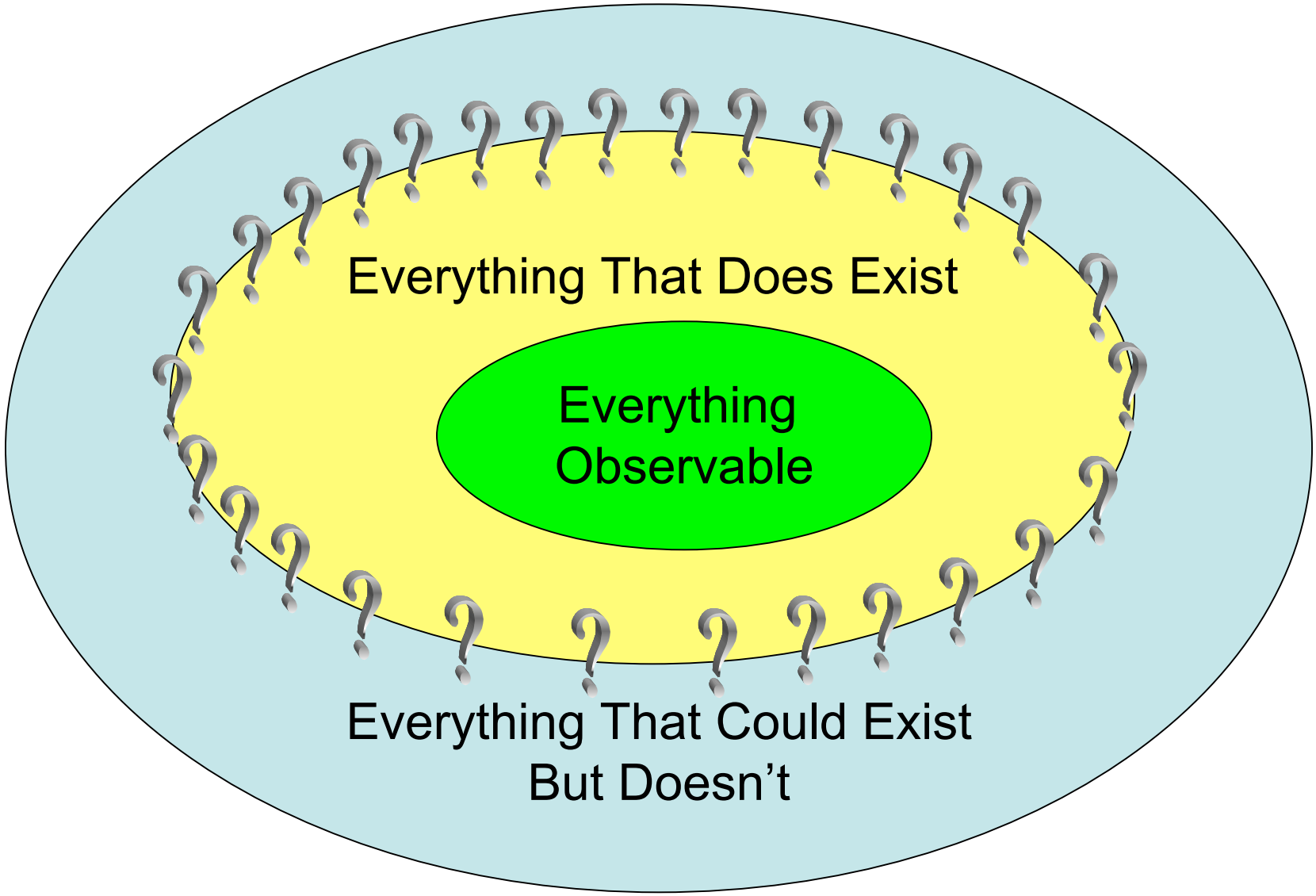
Max Tegmark

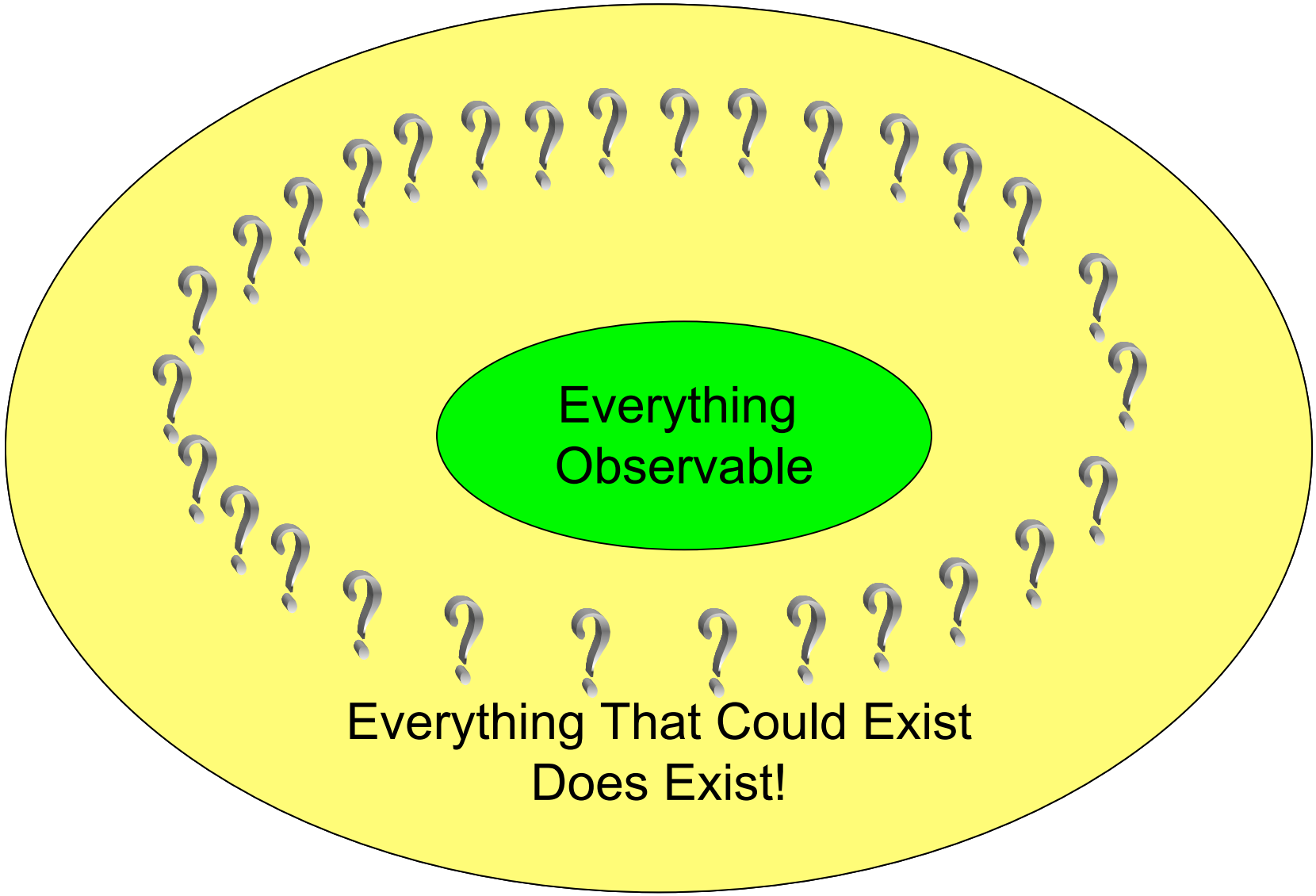
Level 4: All possible logical structures (mathematics)

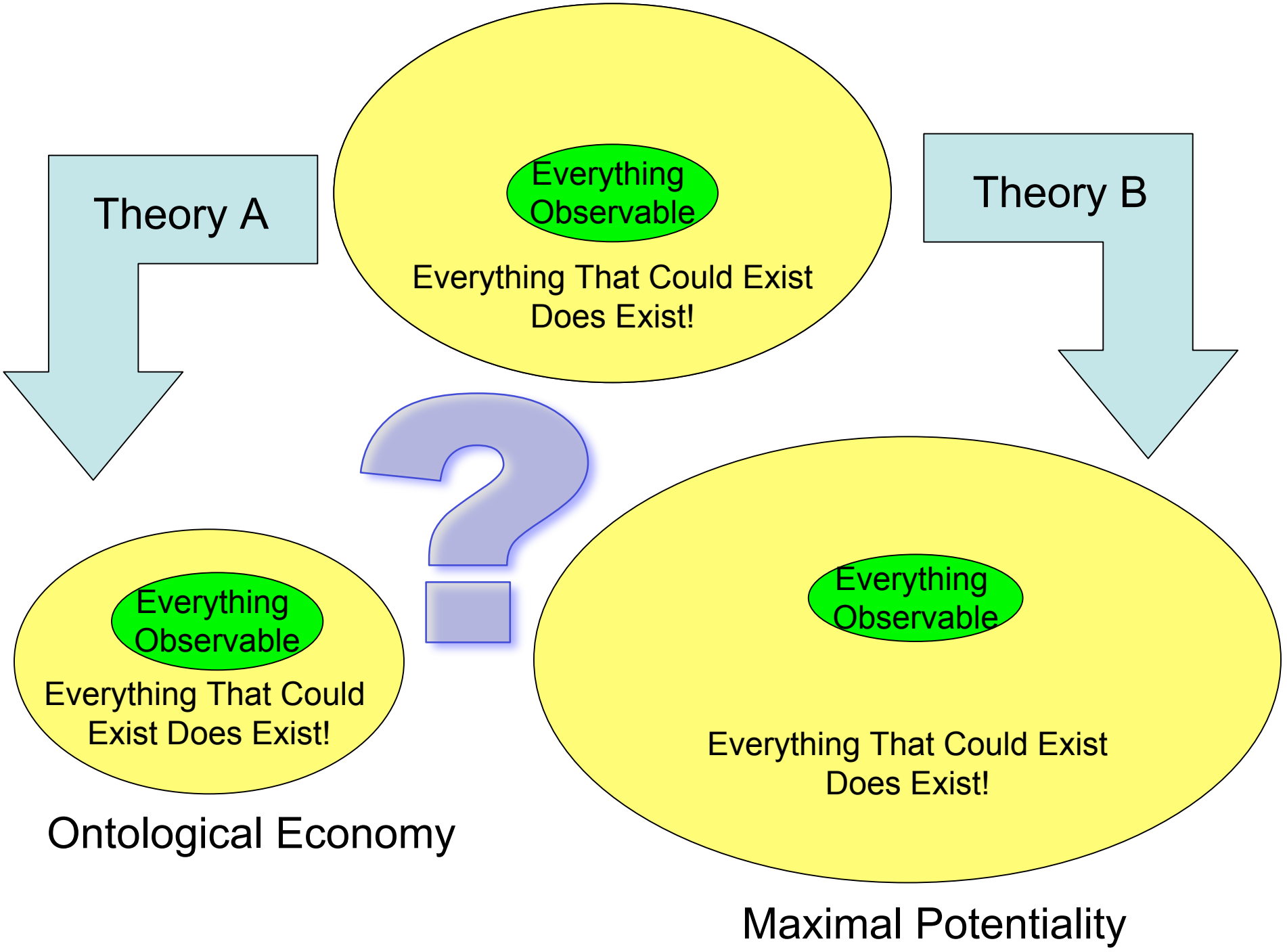


Level 5: Computer simulation (oops!)

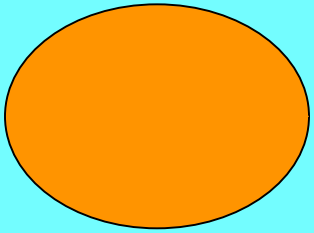
Framework Foibles

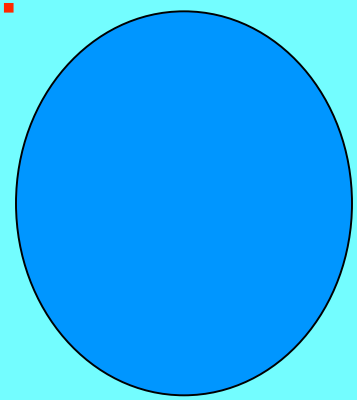


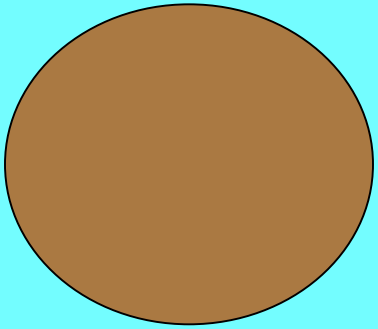

Everything
Observable
Everything That Could Exist
Does Exist!

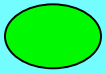

Theory A
Everything Observable
Everything That Could Exist Does Exist!
Theory B
Everything Observable
Everything That Could Exist Does Exist!
Ontological Economy
Everything Observable
Everything That Could Exist Does Exist!
Maximal Potentiality

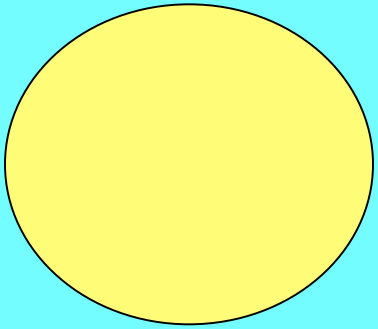
What counts and how?

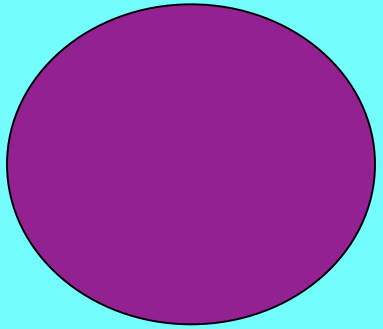


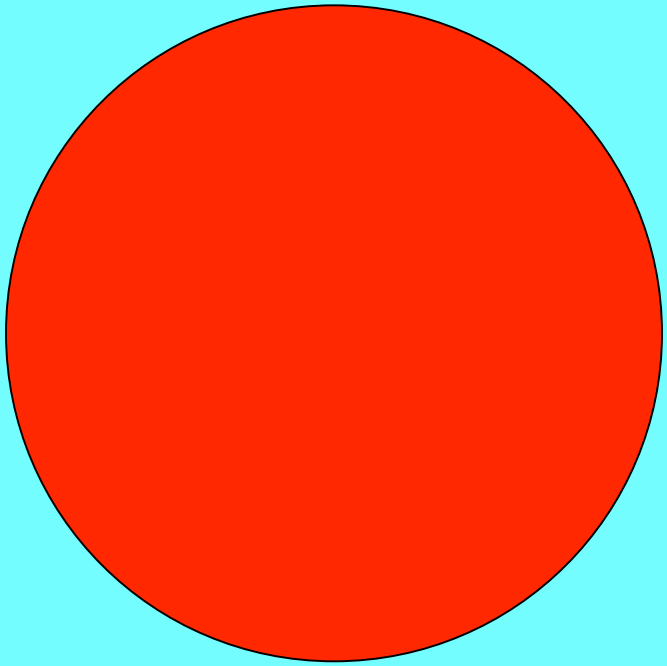


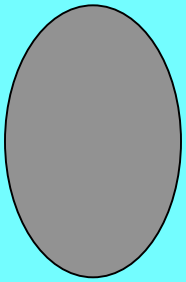








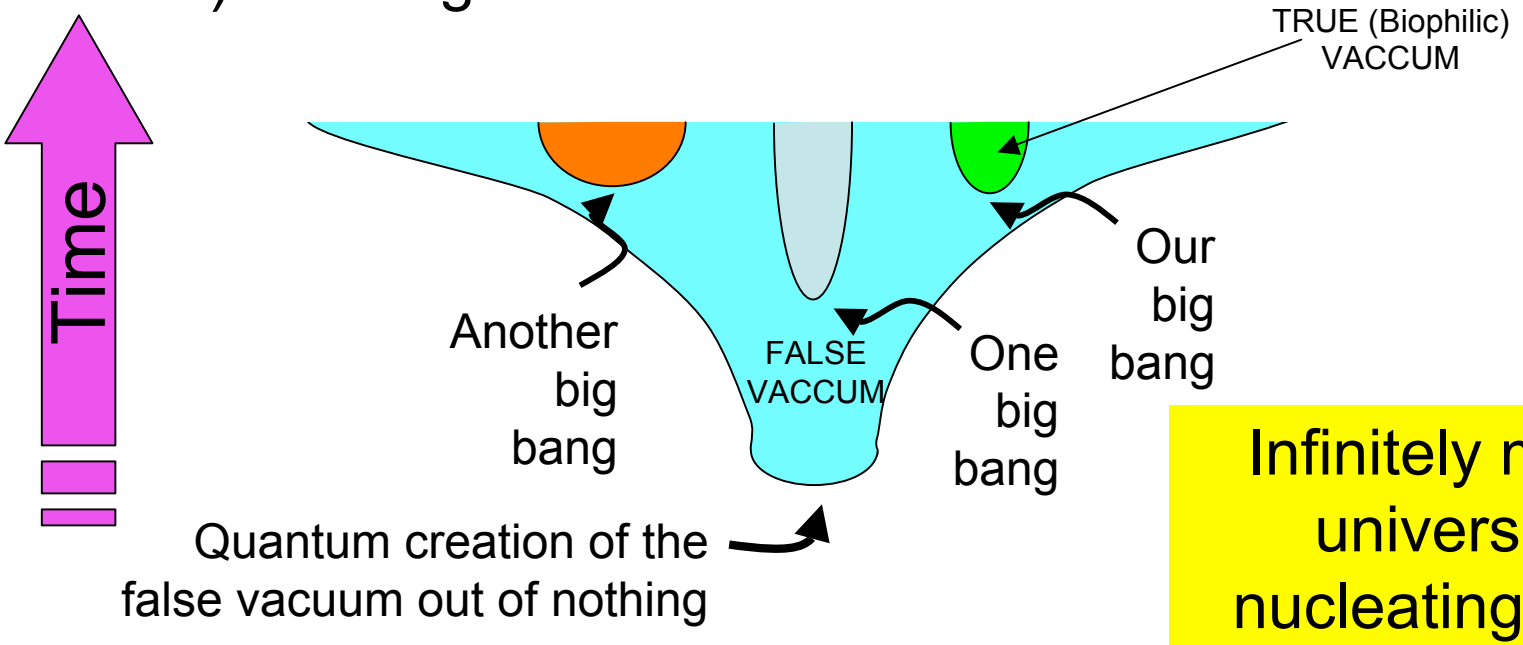




False Vacuum
(unstable, exponentially expands)

Cosmic Inflation

- Basic idea: the universe begins in a false vacuum
- This generates a period of extremely rapid (exponential) expansion of the universe
- Universe doubles in size every 10^{-34} sec
- This can turn a small smooth patch of spacetime (true vacuum) in a large smooth and flat universe



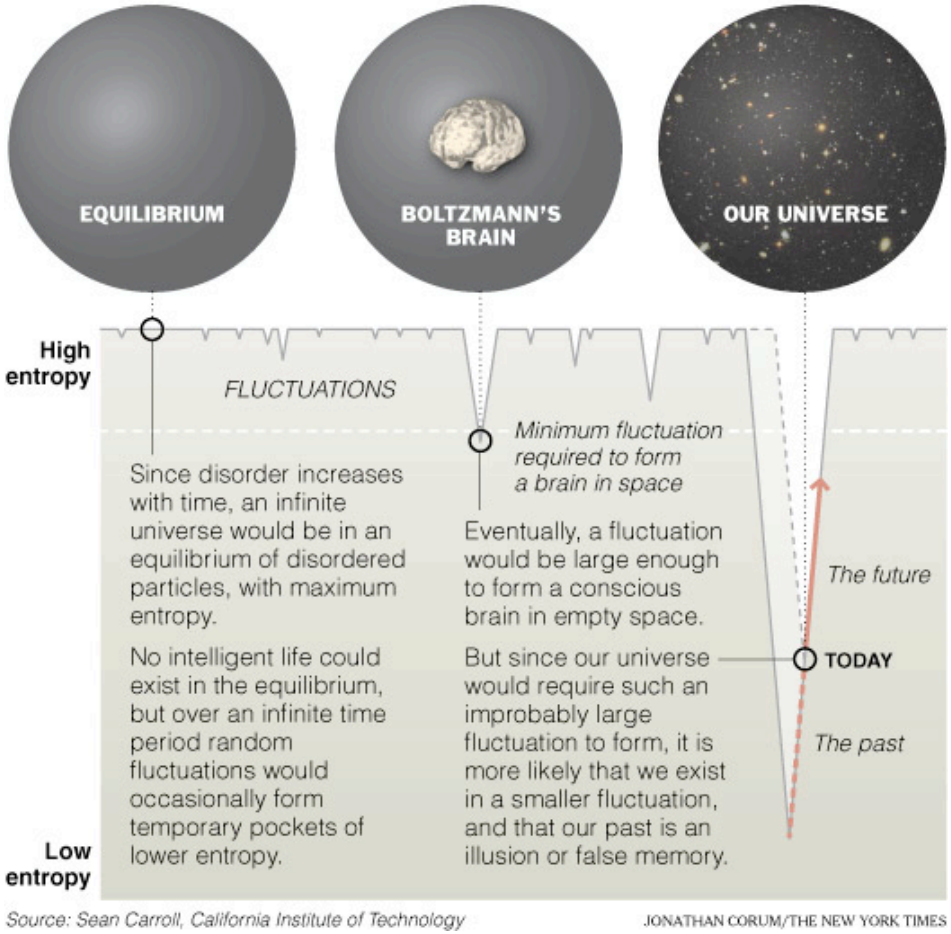
Infinitely many universes nucleating from the false vacuum of the multiverse

Measurement Misery

(Bousso/Freivogel/Yang)

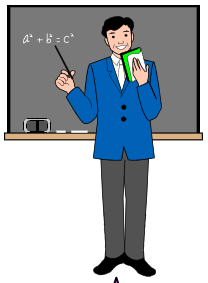
- Counting Universes $P(13.7\ \mathrm{Gyr}) = 10^{-60} P(13.0\ \mathrm{Gyr})$
  - Faster expanding universes should count more
  - Youngness paradox: False vacuum expands fastest, so many more young universes than old ones (Linde;Guth)

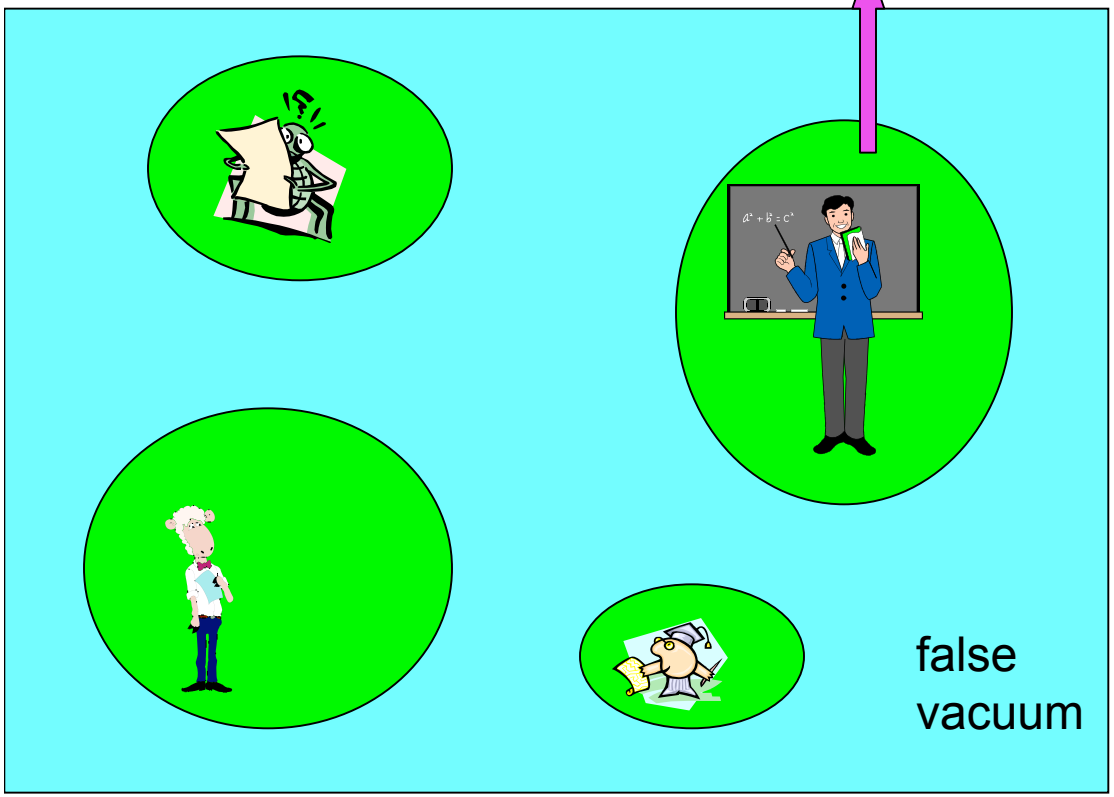
- Counting Observers
  - All observers (or perceptions?) should be treated equally
  - Boltzmann brains: Freak observers far more likely than bio-observers (Page)



What's typical? Are we?

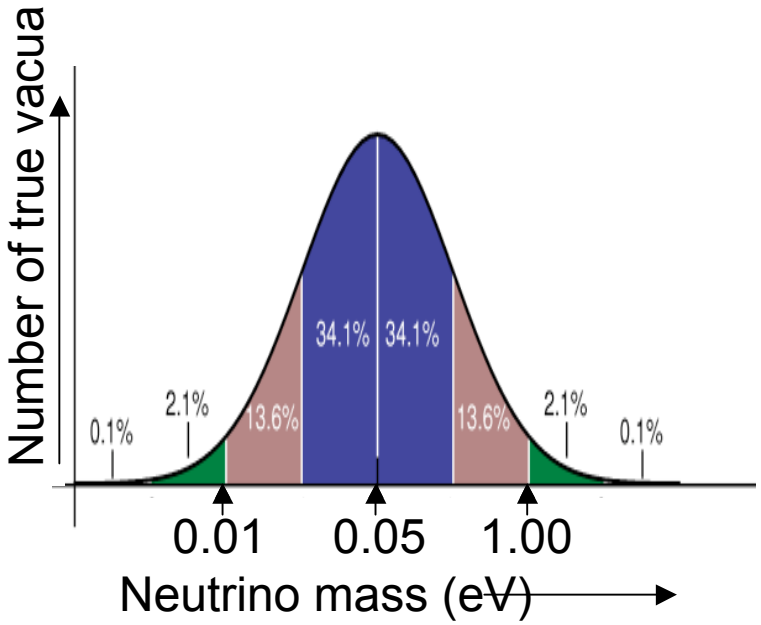
Pick a random observer from the multiverse





= biophilic universe

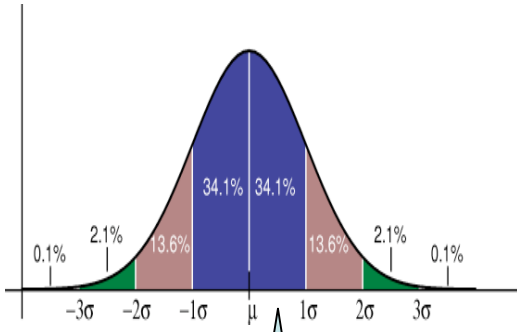
If this observer is in a typical region of the multiverse, then the physical constants in that region that he/she measures can be predicted from a statistical distribution



If you were picked at random from the multiverse, you would expect to measure a neutrino mass somewhere in the middle!

Mediocrity Strategy

- Consider constants of nature that are bio-irrelevant
- Do these fall within 1σ of the mean of a normal distribution?
- If most do -- multiverse?

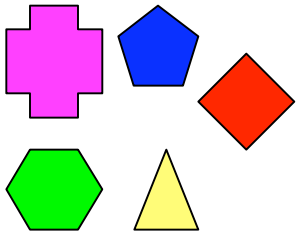


Parameter	Meaning	Definition	Measured value
g	Weak coupling constant		0.6425
θ_W	Weinberg angle		0.4908
g_s	Strong coupling constant		≈ 1.2
μ^2	Quadratic Higgs coefficient	$V(\Phi) = \mu^2\|\Phi\|^2 + \lambda\|\Phi\|^4$	$\sim -10^{-33}$
λ	Quartic Higgs coefficient		~ 1?
G_e	Electron Yukawa coupling		2.94×10^{-6}
G_μ	Muon Yukawa coupling		0.000607
G_τ	Tauon Yukawa coupling		0.0102156233
m_u	Up quark Yukawa coupling		0.000016 ± 0.000007
m_d	Down quark Yukawa coupling		0.00003 ± 0.00002
m_c	Charm quark Yukawa coupling		0.0072 ± 0.0006
m_s	Strange quark Yukawa coupling		0.0006 ± 0.0002
m_t	Top quark Yukawa coupling		1.002 ± 0.029
m_b	Bottom quark Yukawa coupling		0.026 ± 0.003
$\sin\theta_{12}$	Quark CKM matrix angle		0.2243 ± 0.0016
$\sin\theta_{23}$	Quark CKM matrix angle		0.0413 ± 0.0015
$\sin\theta_{13}$	Quark CKM matrix angle		0.0037 ± 0.0005
δ_{13}	Quark CKM matrix phase		1.05 ± 0.24
$\theta_{\rm qcd}$	CP-violating QCD vacuum phase		$< 10^{-9}$

?

Typicality Trouble?

- Many potentialities



- One actuality

Given the data, what's the theory?

Given the theory, what's the data?

$$P(T_K|D) = \frac{P(D|T_K)}{\sum_L P(D|T_L)}$$

T_1

$$P(\text{pentagon}|T_1) = \frac{1}{2}$$

$$P(\text{diamond}|T_1) = \frac{1}{2}$$

$$P(\text{cross or triangle or hexagon}|T_1) = 0$$

$$P(T_1|\text{pentagon}) = \frac{1/2}{1 + 1/2 + 0}$$

$$= 1/3$$

T_2

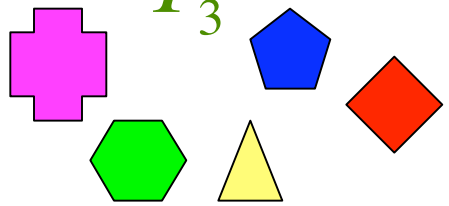
$$P(\text{pentagon}|T_2) = 1$$

$$P(\text{cross or triangle or hexagon or diamond}|T_2) = 0$$

$$P(T_2|\text{pentagon}) = \frac{1}{1 + 1/2 + 0}$$

$$= 2/3$$

T_3



$$P(\text{pentagon}|T_3) = 0$$

$$P(\text{diamond}|T_3) = \frac{3}{5}$$

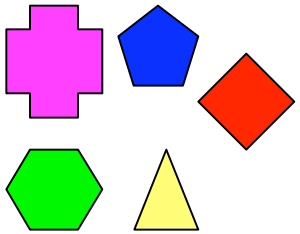
$$P(\text{cross or triangle or hexagon}|T_3) = \frac{2}{5}$$

$$P(T_3|\text{pentagon}) = \frac{0}{1 + 1/2 + 0}$$

$$= 0$$

Typicality Trouble?

- Many potentialities



- One actuality

Given the data, what's the theory?

Given the theory, what's the data?

$$P(T_K|D) = \frac{P(D|T_K)}{\sum_L P(D|T_L)}$$

T_1

or

$$P(\text{pentagon}|T_1) = \frac{1}{2}$$

$$P(\text{diamond}|T_1) = \frac{1}{2}$$

$$P(\text{cross or triangle or hexagon}|T_1) = 0$$

$$P(T_1|\text{pentagon}) = \frac{1/2}{1 + 1/2 + 1/1000} \simeq 1/3$$

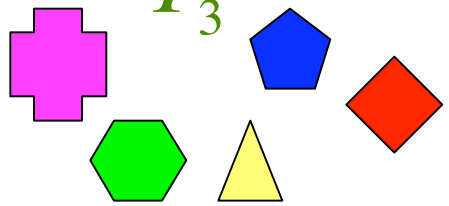
T_2

$$P(\text{pentagon}|T_2) = 1$$

$$P(\text{cross or triangle or hexagon or diamond}|T_2) = 0$$

$$P(T_2|\text{pentagon}) = \frac{1}{1 + 1/2 + 1/1000} \simeq 2/3$$

T_3



$$P(\text{pentagon}|T_3) = \frac{1}{1000}$$

$$P(\text{diamond}|T_3) = \frac{599}{1000}$$

$$P(\text{cross or triangle or hexagon}|T_3) = \frac{2}{5}$$

$$P(T_3|\text{pentagon}) = \frac{1/1000}{1 + 1/2 + 1/1000} = 1/1501$$

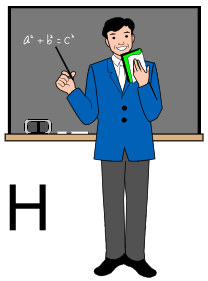
Hartle/Srednicki
0704.2630

Given the data, what's the theory?

Given the theory, what's the data?

What's the chance the theory is correct?

$$P(T_K|D) = \frac{P(D|T_K)P(T_K)}{\sum_L P(D|T_L)P(T_L)}$$



H

J

Which observer is typical?

$$P(\text{human}) = \frac{H}{H+J}$$

$$P(\text{jovian}) = \frac{J}{H+J}$$

$$P(D,H|T_K) = \sum_J \frac{H}{H+J} P(D,H,J|T_K)$$

$J = 0$ or αH

$$P(D,H|T_K) = P(D,H,0|T_K) + \frac{1}{1+\alpha} P(D,H,\alpha H|T_K)$$

$$\simeq P(D,H,0|T_K) \quad \text{if} \quad \alpha \quad \text{is large}$$

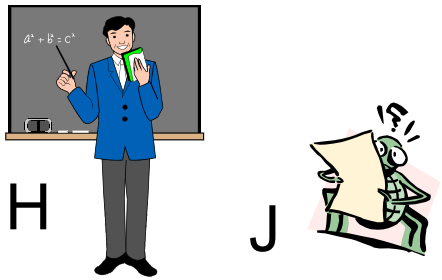
Theories predicting atypical humans (lots of *J's*) are DISFAVOURED

Selection Fallacy!

Copernican Conundrum

- Test theories using all possible data (from *H* and *J*)
- Reason as though you are a randomly selected (bio)-observer in the multiverse

- Test theories using OUR data (H only)
- Reason as though you are a physical system within the observed universe



Which observer is typical?

$$P(\text{human}) = \frac{H}{H+J}$$

Humans typical

Selection Fallacy!

$$P(\text{human}) = 1/N$$

Humans atypical

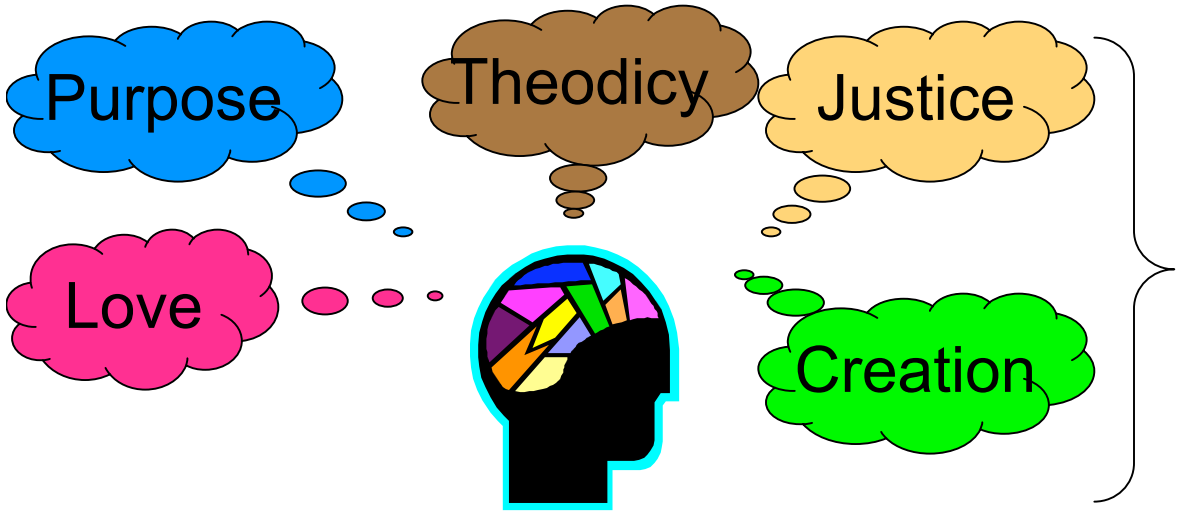
Theology of the Multiverse

Why is there something instead of nothing?

Creatio ex Nihilo

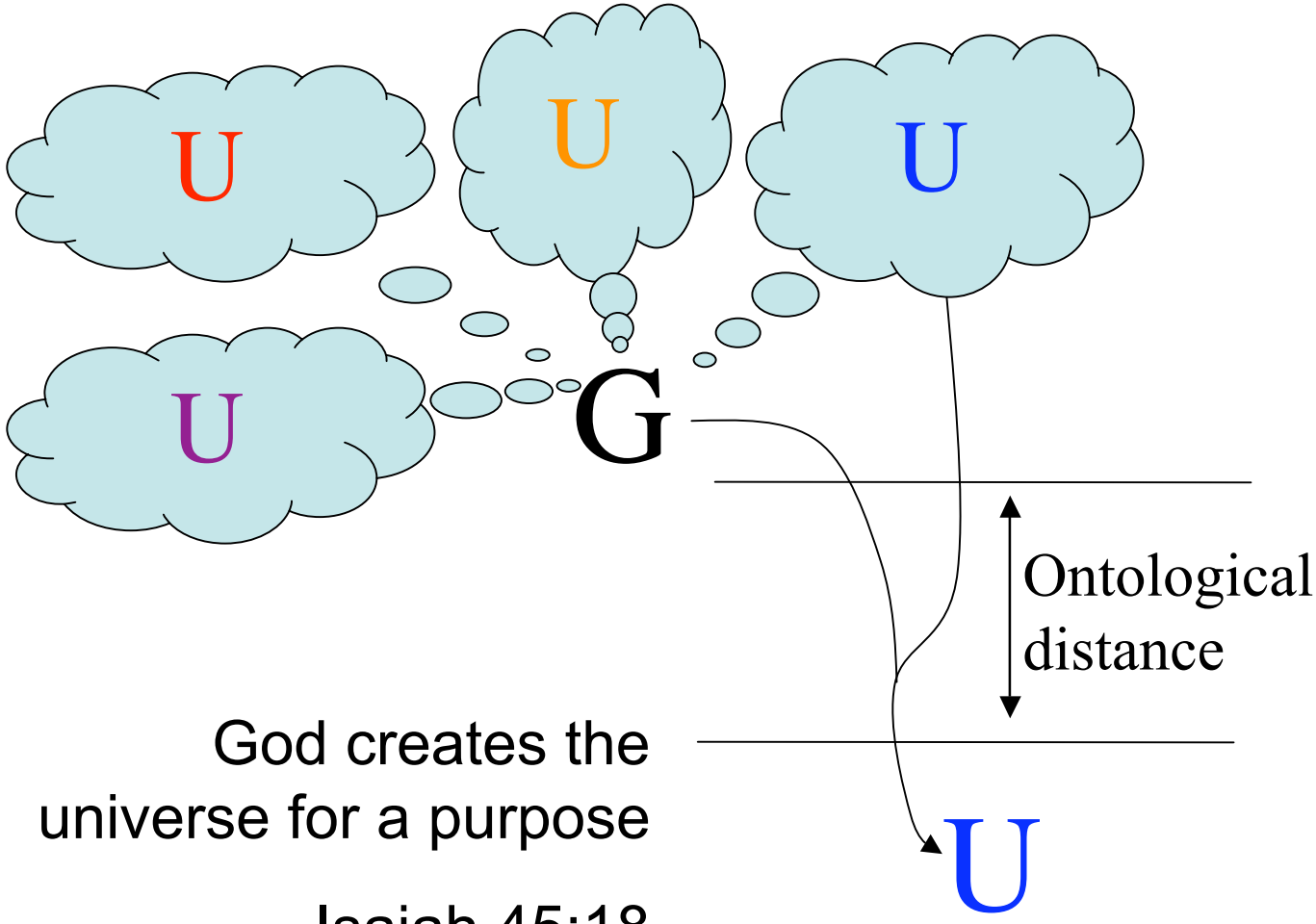
Why is there something instead of everything?

Creatio ex Omnia



What do these mean in a multiverse?

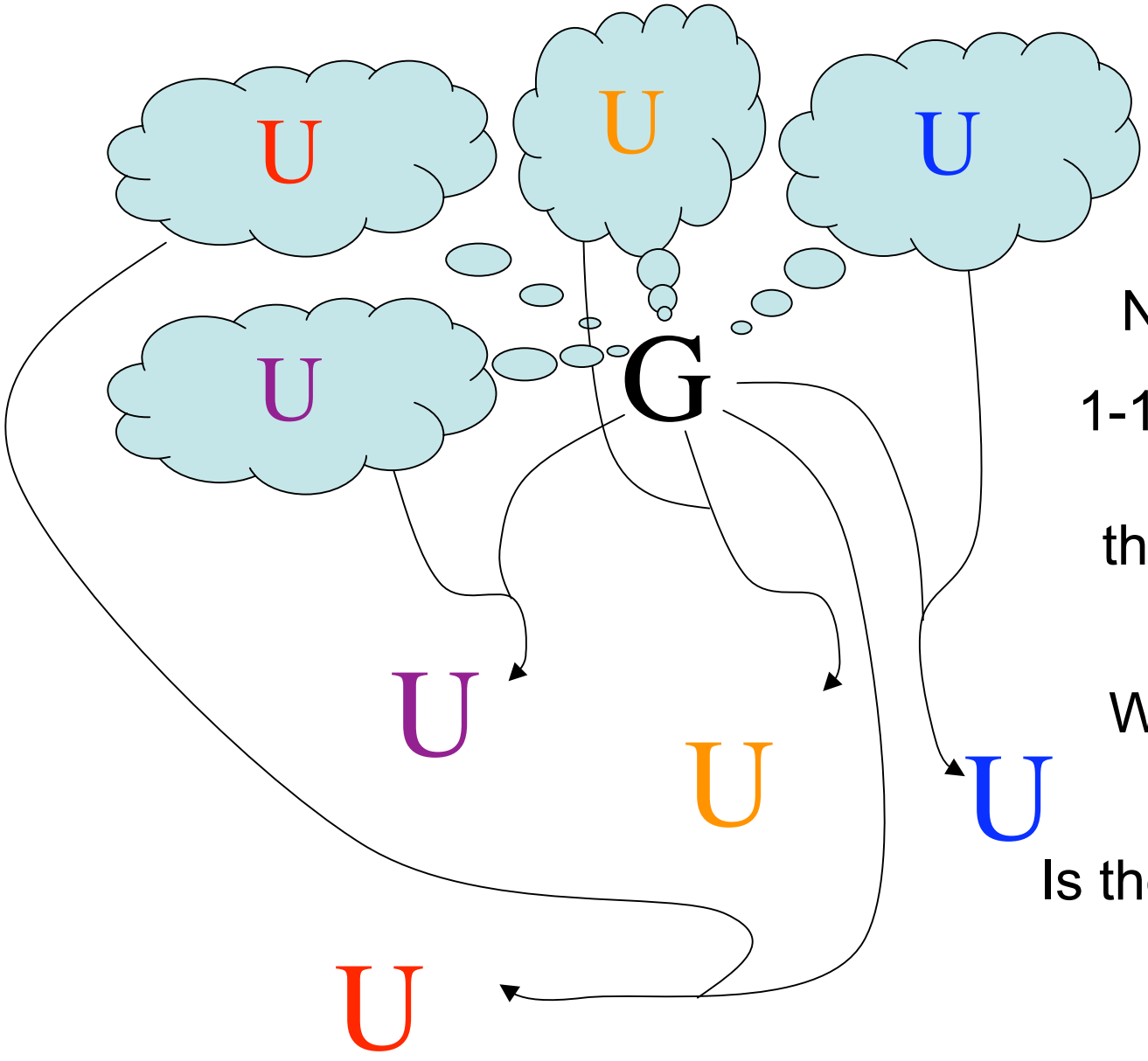
Creatio Ex Nihilo



God creates the
universe for a purpose

Isaiah 45:18

Creatio Ex Omnia



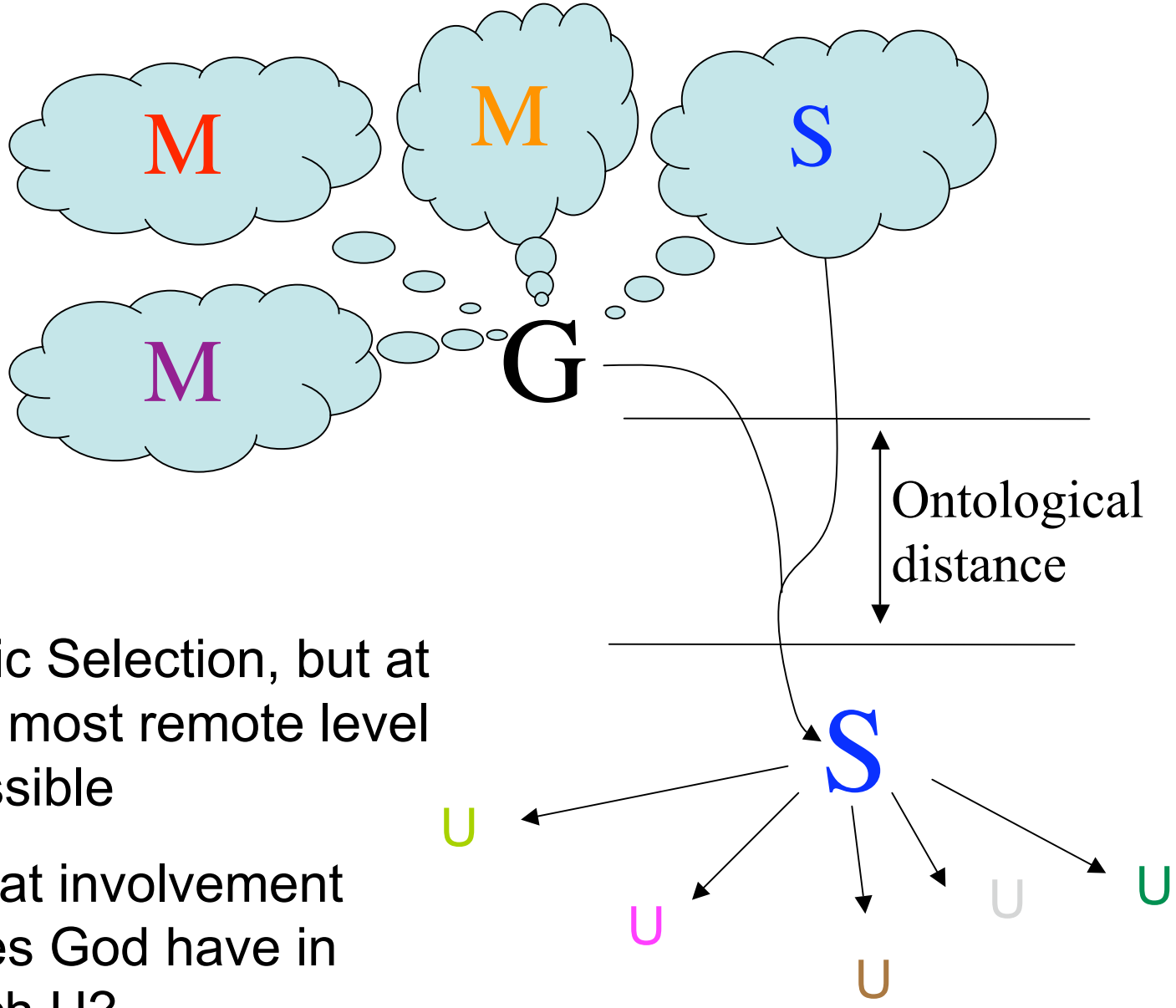
No Telic Selection!

1-1 Correspondence between God's thoughts and God's actions

What function does God serve?

Is there an ontological argument for the existence of the multiverse?

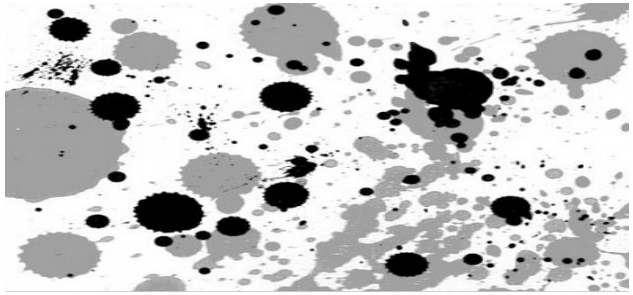
Creatio Ex Nihilo+Omnia



Telic Selection, but at the most remote level possible

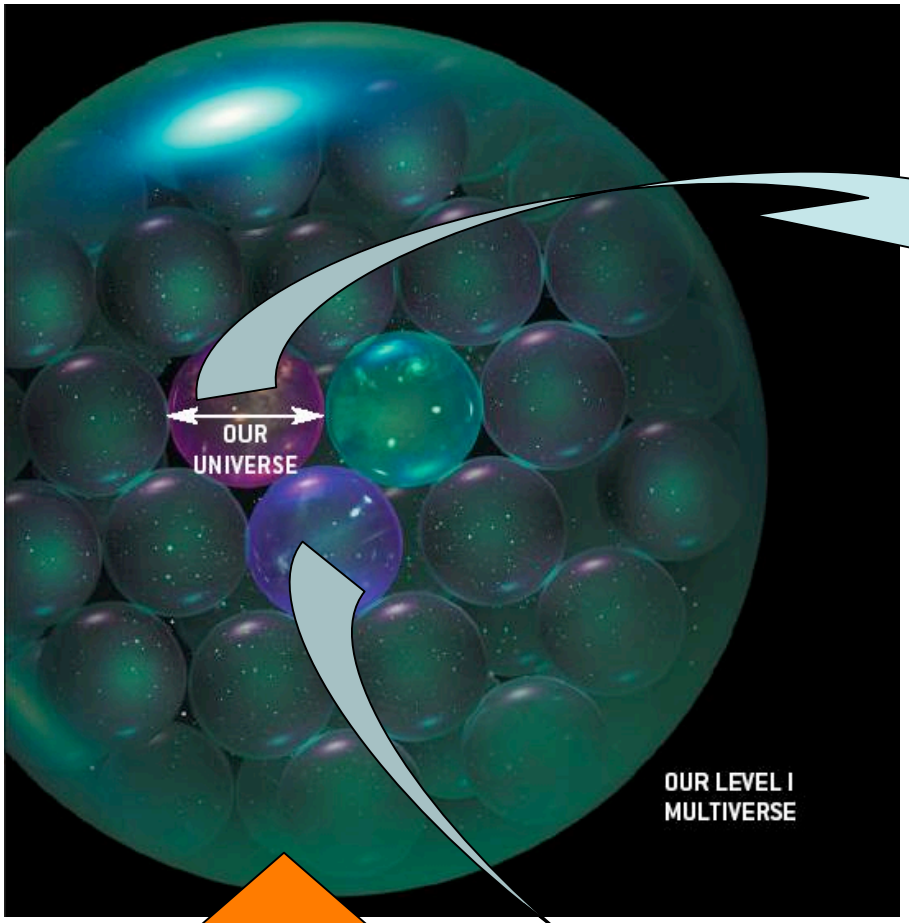
What involvement does God have in each U?

Creativity or Chaos?



Creativity from (mindless) repetition?

Christology Conundrum



Warning!
Also a SETI
Problem

Jesus
Dies on
The Cross

Jesus
Rejects
Cross

Belief in Everything?

A theory of everything* is not the same as a theory of anything

A God who can do anything* is not the same as a god that does everything

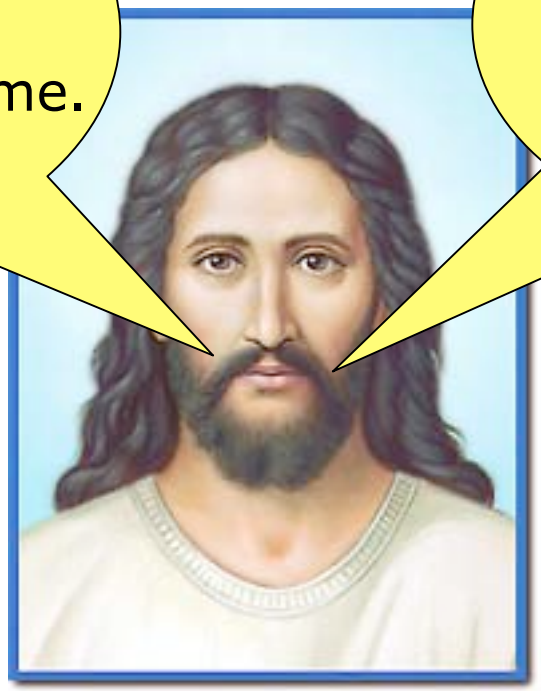
Is the atypicality of our biophilic universe telling us something?

Where Next?

I am the way and the truth and the life. No one comes to the Father except through me.

John 14:6

Jesus affirms a single universe



In my Father's house are many rooms; if it were not so, I would have told you.

John 14:2

Jesus affirms a multiverse

Ingredients for a Theistic Cosmos