

The Anthropic Principle meets Big History

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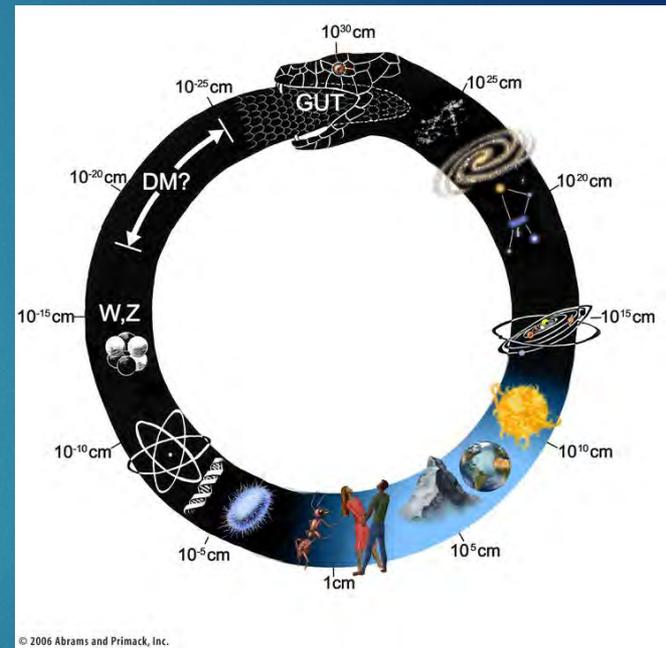
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Abstract: The Anthropic Principle states that the universe is friendly for life and maybe intelligence. This principle can illuminate many "Goldilocks" conditions discussed in Big History. It is not known whether the principle is just a reflection of the conditions because we exist (weak version) or whether there is a stronger causal connection (strong version). Connections between fundamentals of particle physics and the large-scale universe has been explored for over 50 years. Some connections are direct physics relationships, e.g., the size of humans is about the square root of a typical planet and an atom. Other conditions are not easily explained. The current attempts to explore these relationships includes the role of time, math, quantum mechanics, and consciousness. Two major hypothesis for the anthropic principle, the multiverse and the participatory universe, are compared along with potential measurements which might resolve this mystery.

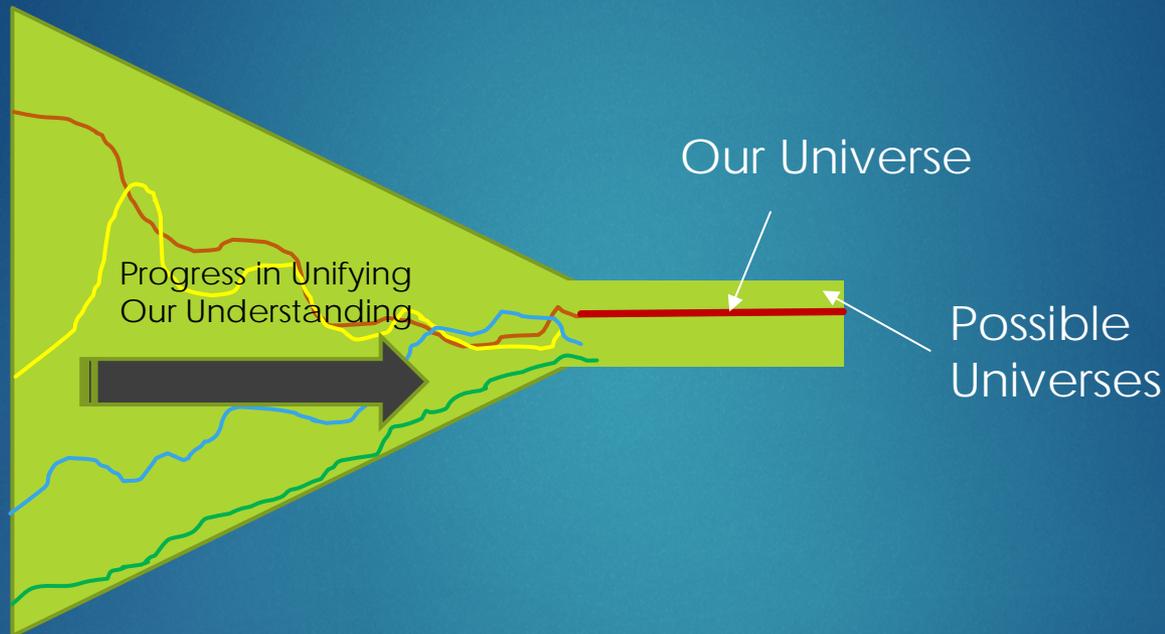
Overview

- ▶ Introduction
 - ▶ Examples and History
 - ▶ Big History Connection
 - ▶ Types of coincidences
- ▶ Current areas of exploration
 - ▶ New relationships
 - ▶ Possible explanations
 - ▶ Evolution and quantum physics
 - ▶ Tests



<https://www.pinterest.com/pin/415246028116378949/>

Theory of Everything is not Unique



- ▶ Possible explanation:
 - ▶ Haven't found the right unique theory yet
 - ▶ Multiple (evolving) universes
 - ▶ Self consistency (Goswami simple thought experiment)

Yet universe seems to be set up for life

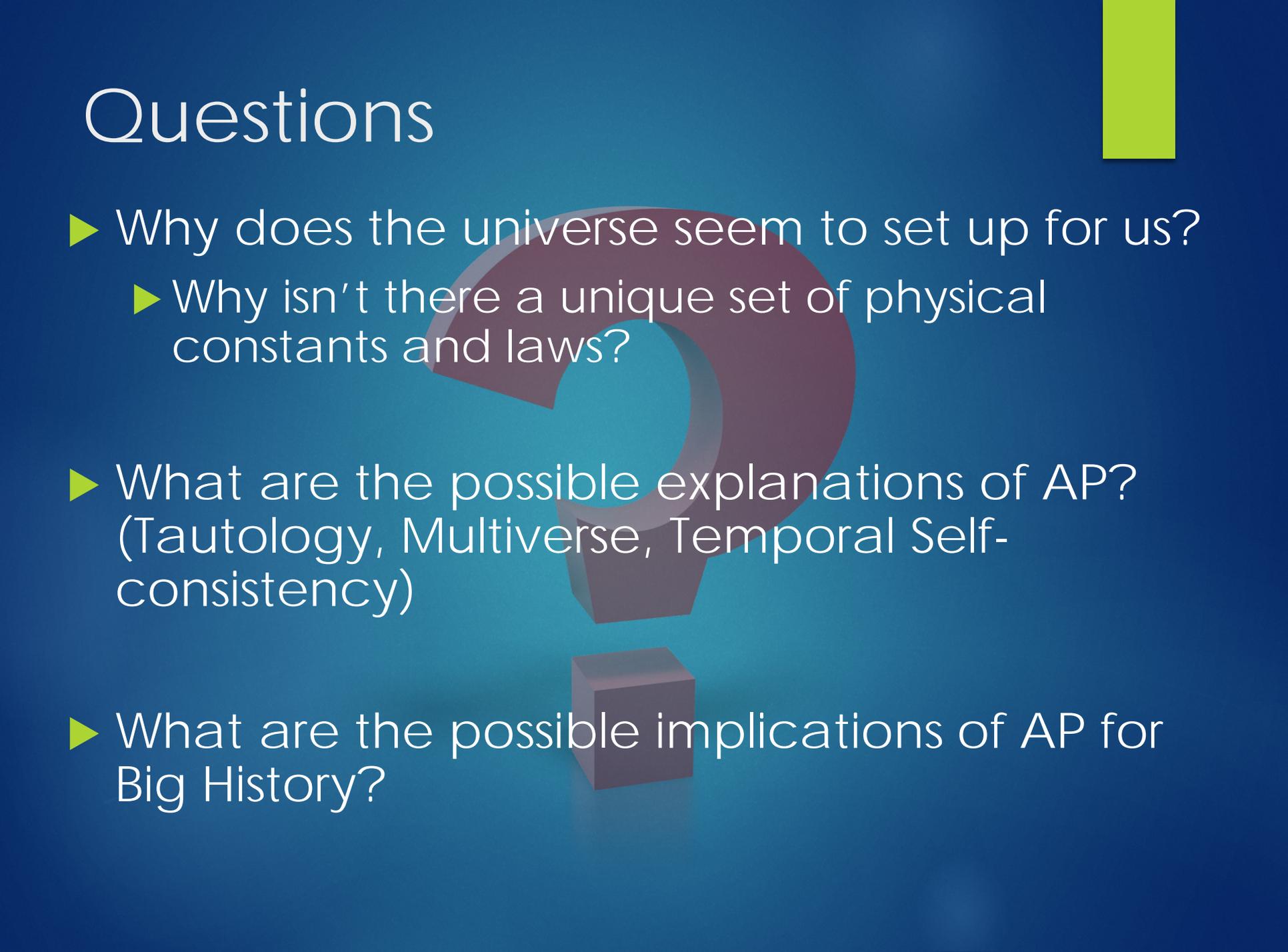
- ▶ Production of Carbon
 - ▶ Unique chemistry
 - ▶ Formation depends on obscure nuclear properties
 - ▶ Need enough time to generate enough carbon through stellar generations
- ▶ Relative strength of fundamental forces
 - ▶ Gravity: too strong- collapse; too weak- not interesting structures
 - ▶ Electromagnetic: too strong- proton unstable

Physics of Life

The diagram illustrates the 'Physics of Life' through a sequence of four stages: a simple atom with a central nucleus and orbiting electrons, a yellow sphere representing a star or planet, a colorful, multi-colored explosion representing a supernova or stellar event, and a DNA double helix structure. Below these stages is a periodic table of elements, color-coded to show groups: Hydrogen (H) and Helium (He) are blue; Lithium (Li) and Beryllium (Be) are yellow; Sodium (Na) and Magnesium (Mg) are green; Boron (B), Carbon (C), Nitrogen (N), Oxygen (O), Fluorine (F), and Neon (Ne) are orange; Potassium (K), Calcium (Ca), Scandium (Sc), Titanium (Ti), Vanadium (V), Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Gallium (Ga), Germanium (Ge), Arsenic (As), Selenium (Se), Bromine (Br), and Krypton (Kr) are red; Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), Niobium (Nb), Molybdenum (Mo), Technetium (Tc), Ruthenium (Ru), Rhodium (Rh), Palladium (Pd), Silver (Ag), Cadmium (Cd), Indium (In), Tin (Sn), Antimony (Sb), Tellurium (Te), Iodine (I), and Xenon (Xe) are purple; and Cesium (Cs), Barium (Ba), Hafnium (Hf), Tantalum (Ta), Tungsten (W), Rhenium (Re), Osmium (Os), Iridium (Ir), Platinum (Pt), Gold (Au), Mercury (Hg), Thallium (Tl), Lead (Pb), Bismuth (Bi), Polonium (Po), Astatine (At), and Radon (Rn) are dark purple.

http://www.mashpedia.com/Fine-tuned_universe

Questions



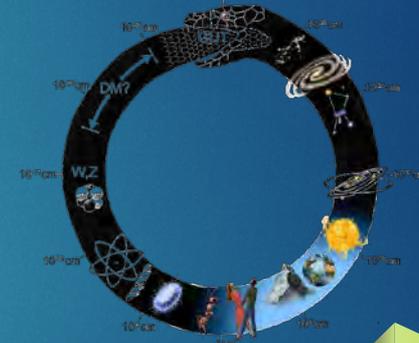
- ▶ Why does the universe seem to set up for us?
 - ▶ Why isn't there a unique set of physical constants and laws?
- ▶ What are the possible explanations of AP? (Tautology, Multiverse, Temporal Self-consistency)
- ▶ What are the possible implications of AP for Big History?

Connection to Big History

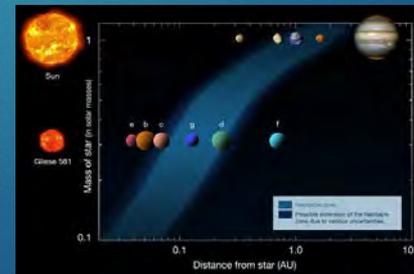
- ▶ Why do “Goldilocks” conditions exist?
 - ▶ Too fast: not enough time to form structures
 - ▶ Too slow: collapse into one black hole
- ▶ How is fundamental physics related to large scale universe evolution and our human scale?
- ▶ Connections to
 - ▶ Development of Universe structures (Physics)
 - ▶ Complex Adaptive Systems evolution (Energy flow and information)
 - ▶ But some conditions, e.g., habitable zone around sun, by selection



<https://www.bighistoryproject.com>



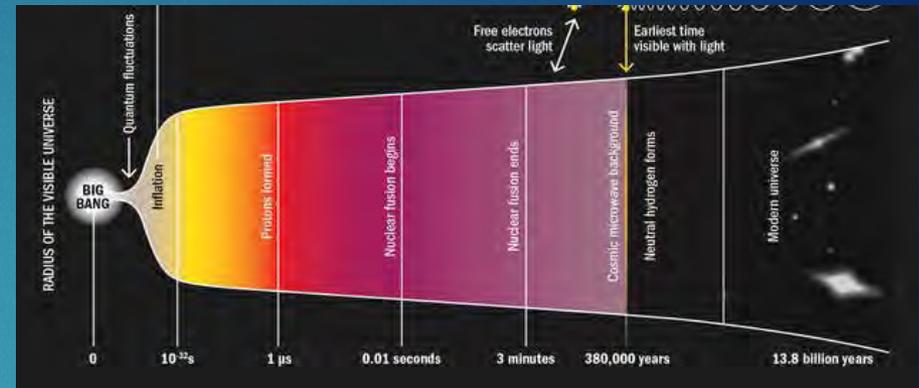
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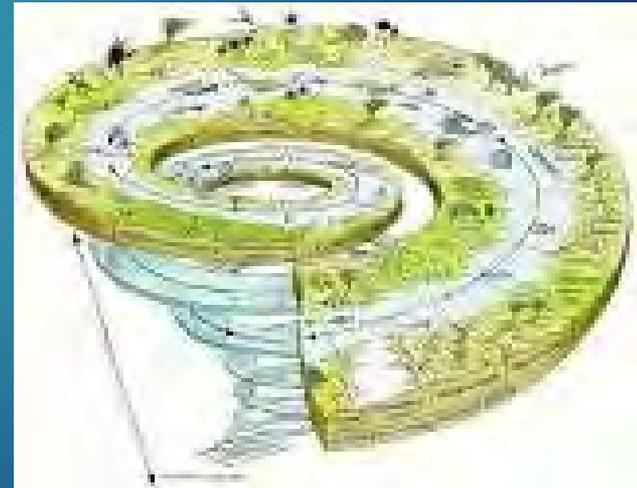
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Types of Coincidences

- ▶ Cosmology:
 - ▶ Constants and laws
 - ▶ Sizes and times of Universe, galaxies, stars, planets, humans and atoms
- ▶ Evolution:
 - ▶ Life using unique properties of quantum mechanics to facilitate processes



www.helmholtz.de



www.kidsgeo.com

Types of Coincidences: Cosmology

- ▶ Qualitative laws:
 - ▶ Gravity is not repulsive
 - ▶ Same charges not attract
 - ▶ Quantum mechanics needed for atomic stability
- ▶ Relative force constants (Gravity, Electromagnetism, Strong nuclear, dimensions)
- ▶ Universe parameters (initial clumping, expansion, density)



- 1) ϵ - Epsilon = 0.007
Relative Amount of hydrogen that converts to Helium via Fusion in the big bang
- 2) $N = 10^{36}$
Strength of the electric force divided by the strength of gravity
- 3) Ω - Omega
Relative Density of the Universe
- 4) Λ - Lambda
Cosmological Constant
- 5) Q
Amplitude of Irregularities in the CMB
- 6) D
Number of Spatial Dimensions

Image Credit: Festival della Scienza from Genova

Festival della Scienza from Genova

Sizes



Shear force not exceeded when falls

Rock: Not enough mass for large gravitational forces;



Energy needed to shear



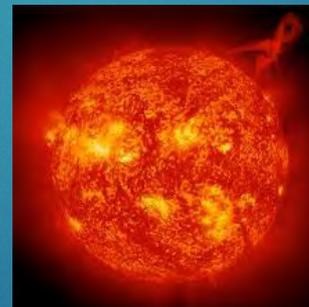
Gravitational force at surface



Planet: large gravitational forces overcome molecular shear forces to make a sphere;

Opposite Charges Attract

Atom: Electrons tendency to spread out due to uncertainty principle is balanced by electrical force with proton.



nssdc.gsfc.nasa.gov

Star: large gravitational forces balanced by thermal pressure from nuclear fusion;

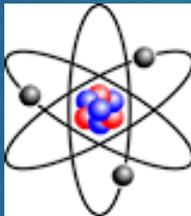
Time

Diameter of the Universe



www.theatlantic.com

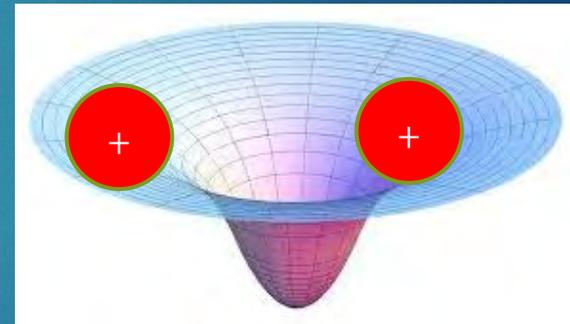
Diameter of an atom



Electrical Force



Gravitational Force



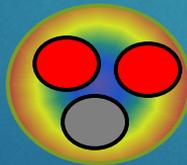
commons.wikimedia.org

- First noticed by Dirac in 1937- Does gravity change with time?
- Refined Dicke 1961- Relationship exists when conditions are right for life, i.e., a few stellar lifetimes to generate enough material

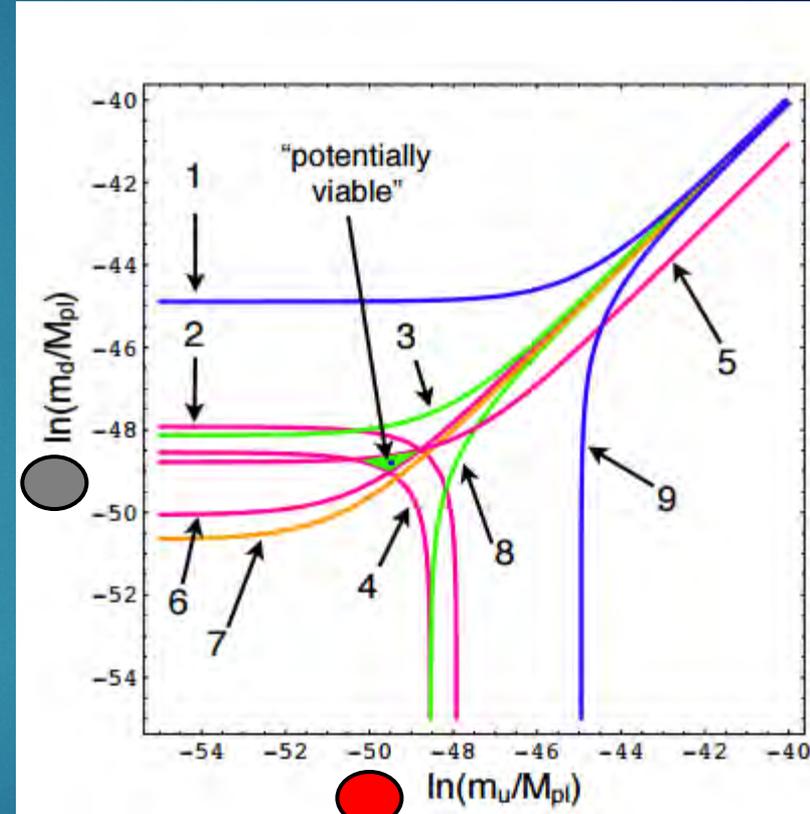
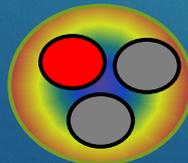
New Relationships- Mass of quarks

- ▶ Difficult to determine mass (most mass of proton is other)
- ▶ Expect proton to have heavier mass since it has a charge; compared to the neutral neutron

Proton



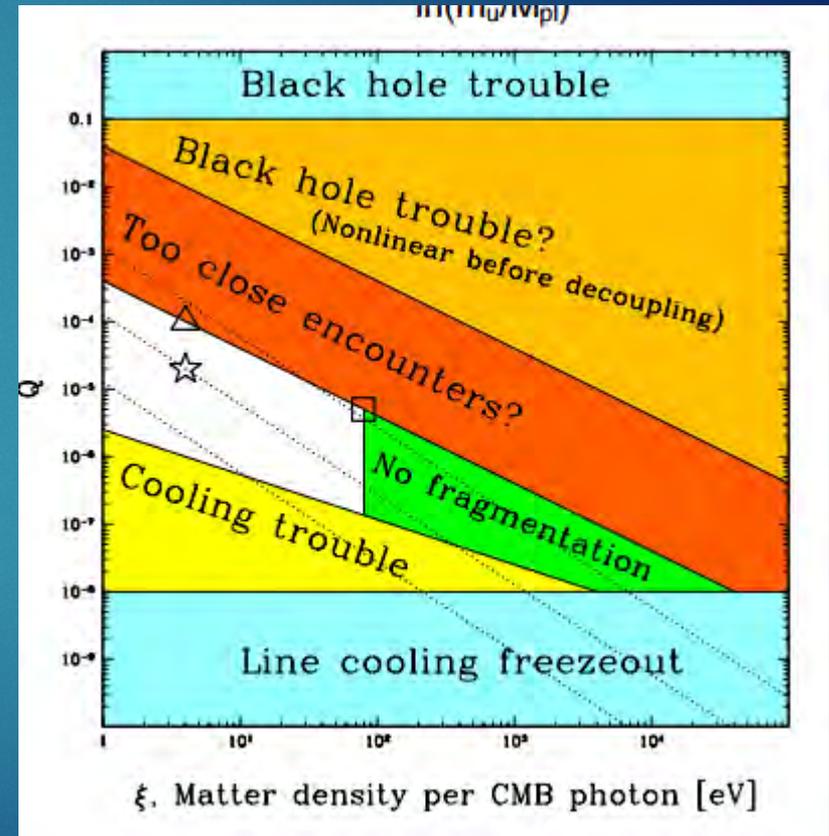
Neutron



Barnes L. A. (2012) The Fine-Tuning of the Universe for Intelligent Life. Publications of the Astronomical Society of Australia 29, 529-564. <http://arxiv.org/pdf/1112.4647.pdf>

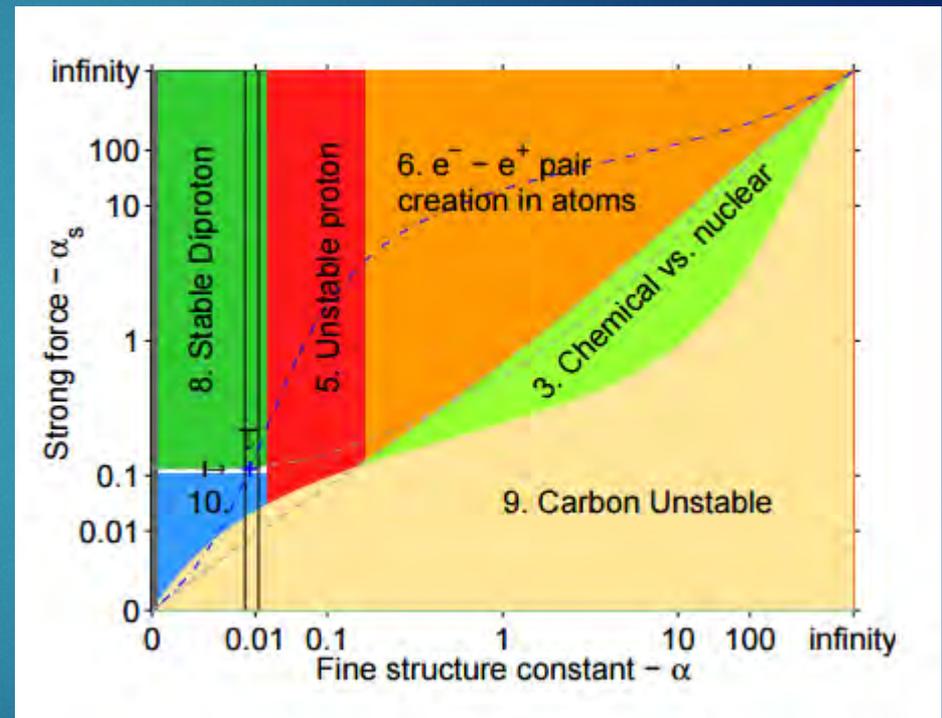
New Relationships-Wedges (Cosmological Constants)

- ▶ Density and Initial Clumping
 - ▶ Condense into black holes
 - ▶ Condense with potential close encounters
 - ▶ Diffuse before structures
 - ▶ Cool too slow



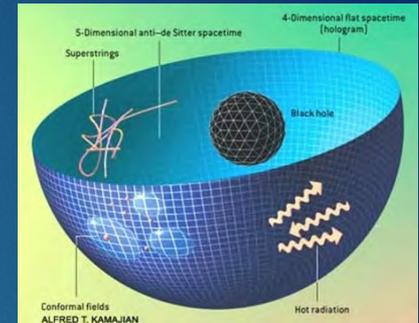
New Relationships- Wedges (Particle Constants)

- ▶ Density and Initial Clumping
 - ▶ Condense into black holes
 - ▶ Condense with potential close encounters
 - ▶ Diffuse before structures
 - ▶ Cool too slow

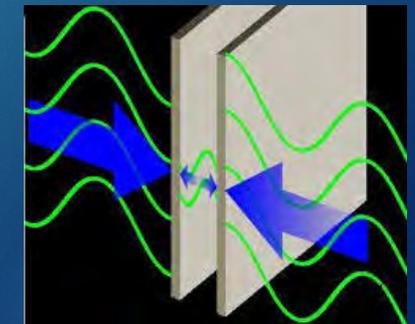
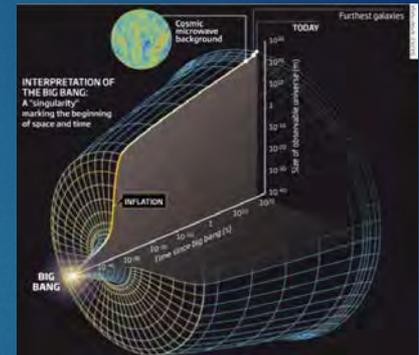


New Relationships- Information Limits

- ▶ One possible view- information bound based on Holographic principle
 - ▶ Entropy of black hole proportional to surface area not volume
 - ▶ Traditional view: Physics laws-> matter-> Information
 - ▶ Possible new view: Information-> Physics laws-> Matter (Laws as software)
 - ▶ What is relationship between math and physics?
 - ▶ Try to apply to areas which might be information limited to give answers close to observations:
 - ▶ Early universe: Leads to expansion factor of about 10^{20}
 - ▶ Reduces amount of theoretical dark energy by 10^{122}



<http://www.science20.com/>



Possible paths to unification?

Methods

- Amplituhedron
- Multiple interacting classical worlds

Gravity

- Strings/ M-Brane
- Loops /Triangulation
 - Entropy
- E8 / Supersymmetry

Information

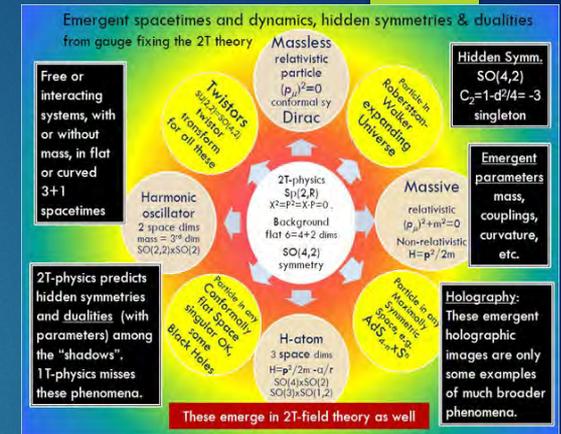
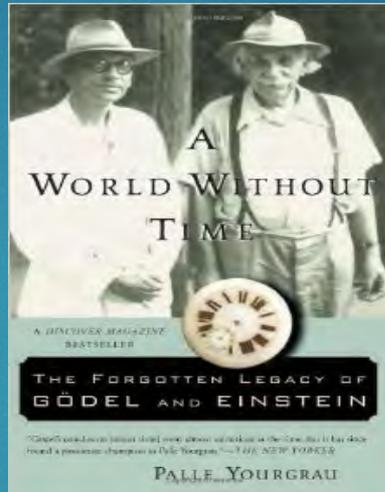
- Holographic
- Math and Physics
- Process Physics

Time

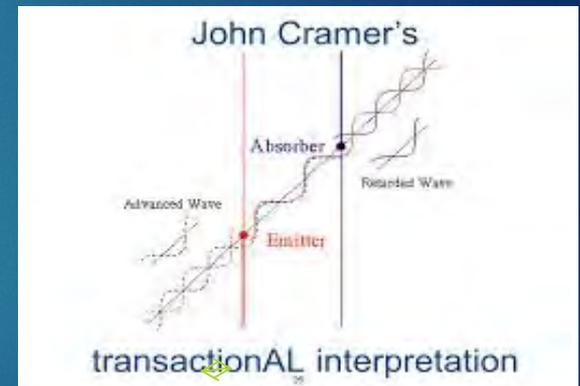
- Two time dimensions
- Emergent (No time)
- Temporal handshaking
 - Self-consistent

Current Areas: Time

- ▶ What is the meaning of time?
- ▶ Two times (Isaac Bars)
- ▶ No Time (Godel)
- ▶ Handshake between past and future (John Cramer)
- ▶ Emergent
- ▶ Self Consistent (Davies)



<http://physics.usc.edu/~bars/>

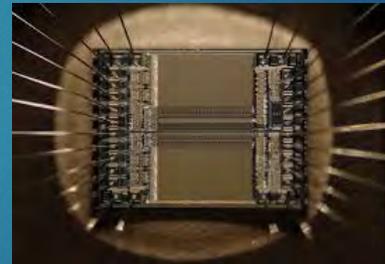
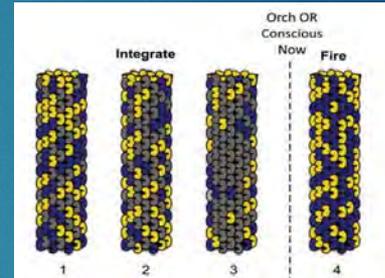
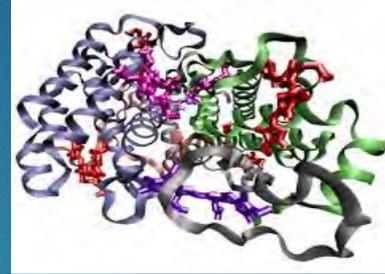


<http://www.physicsoftheuniverse.com/>



Current Areas: Evolution

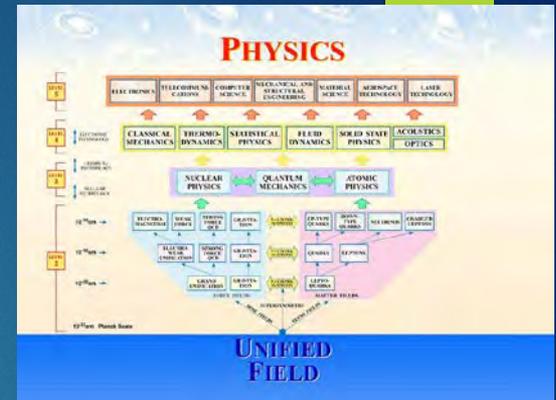
- ▶ Protein
 - ▶ Folding
 - ▶ H-bonding
 - ▶ Enzymes
- ▶ Structures
 - ▶ Photosynthesis
 - ▶ Microtubules
- ▶ Technology
 - ▶ Laser, metals, semiconductors



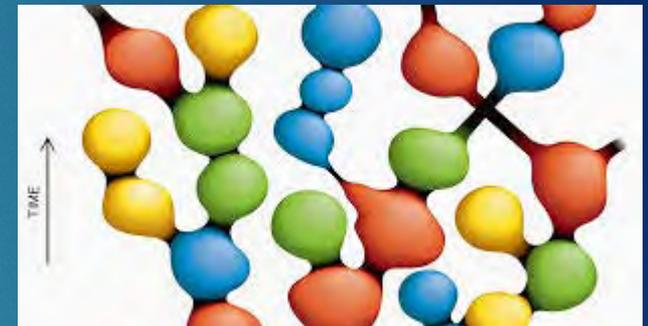
- ▶ Brain

The most
incomprehensible thing
about the universe is
that it is comprehensible
- Albert Einstein

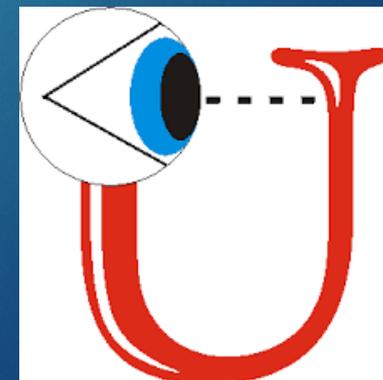
Possible Explanations



<http://www.collective-evolution.com>



<http://arstechnica.com/science/2013/06>



plus.maths.org/content/it-bit

▶ A complete theory is out there

- ▶ A unique theory exists with determined constants
- ▶ Why that set of laws (e.g., quantum physics)?

▶ Multiverse

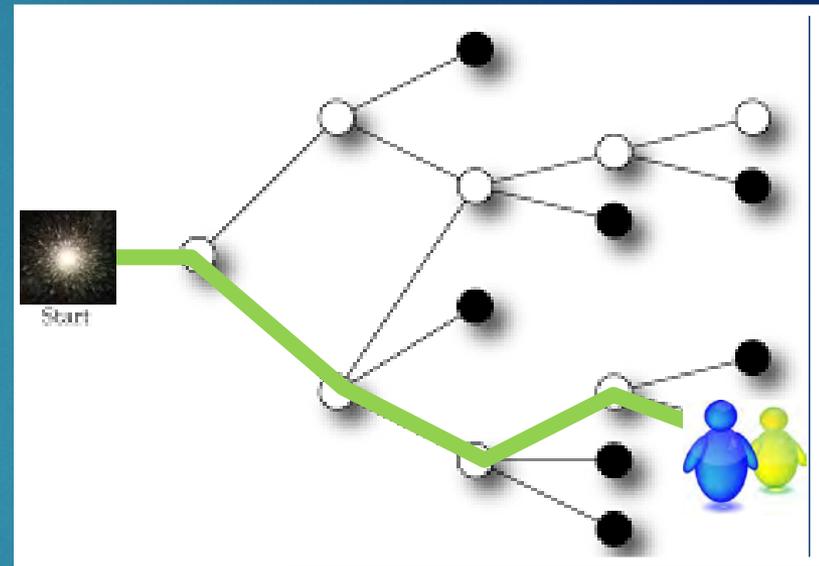
- ▶ Eternal inflation- multiple universes with different constants
- ▶ Evolving universes- universe can create new universes with slightly different parameters
 - ▶ Favoring black holes
 - ▶ Favoring consciousness
 - ▶ What is the competition for resources?

▶ Self Consistency

- ▶ Self-Aware Universe (Goswami)
 - ▶ Universe is a quantum parallel computer to find consciousness (by collapsing wavefunction)
- ▶ John Wheeler, Paul Davies

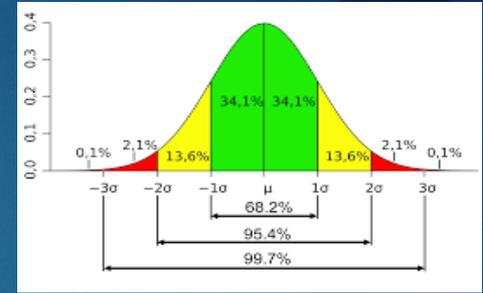
Simple Self-Consistent Though Experiment

- ▶ Standard Quantum Dynamics
 - ▶ Systems evolve if they travel many paths
 - ▶ One path is determined when a measurement is made (by conscious observer)
- ▶ Consider universe from Big Bang
 - ▶ Universe system tries all potential paths
 - ▶ Until a conscious observer evolves to collapse the system
 - ▶ The universe would be a massive parallel quantum computer to find life



Tests

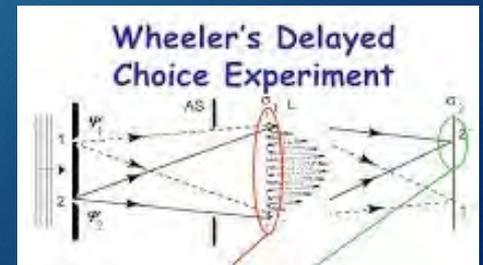
- ▶ How improbable are our constants given that life needs to exist?
 - ▶ (e.g., likelihood of distribution of dark energy)
- ▶ Tests limits of combinations via new cosmological and particle experiments
 - ▶ (e.g., structure evolution simulations, supersymmetric particles, cosmic ray energies)
- ▶ Look for evidence of consequences of multiple universes
 - ▶ (e.g., heat spot in CBR, force strength versus distance)
- ▶ Test quantum mechanics fundamentals
 - ▶ (e.g., collapse, neuron operation, delayed choice experiment, holometer)



<http://www.muelaner.com/metrology/>

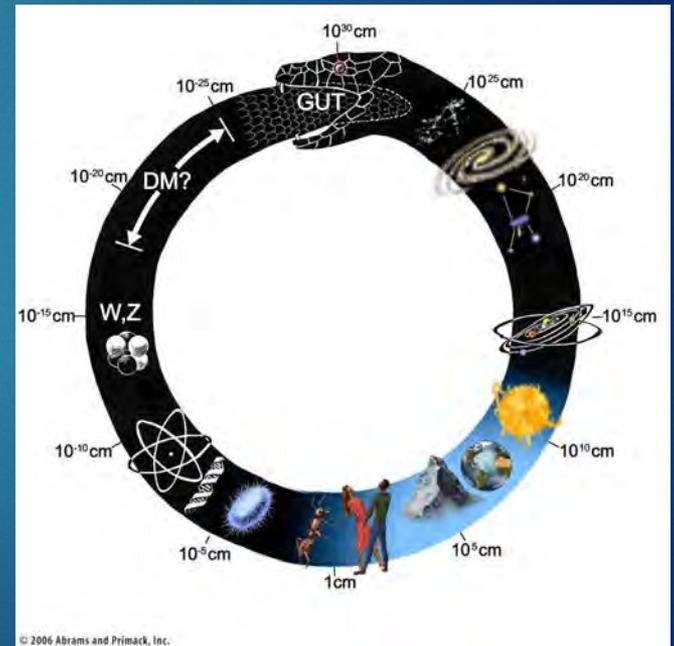


www.astronomy.com



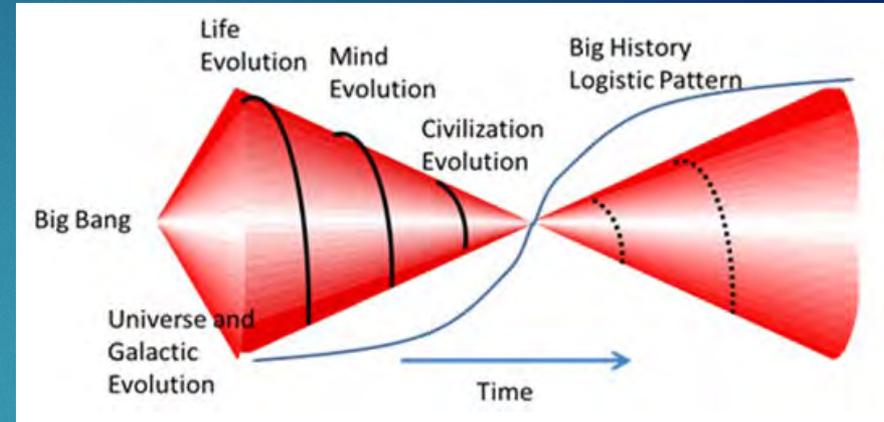
Conclusions

- ▶ The anthropic principle contributes to the understanding of Big History
 - ▶ Some Goldilocks coincidences
 - ▶ Relationships of size and time
- ▶ Much research is continuing
 - ▶ New relationships
 - ▶ Possible Explanations
 - ▶ Evolution and quantum physics
 - ▶ Tests

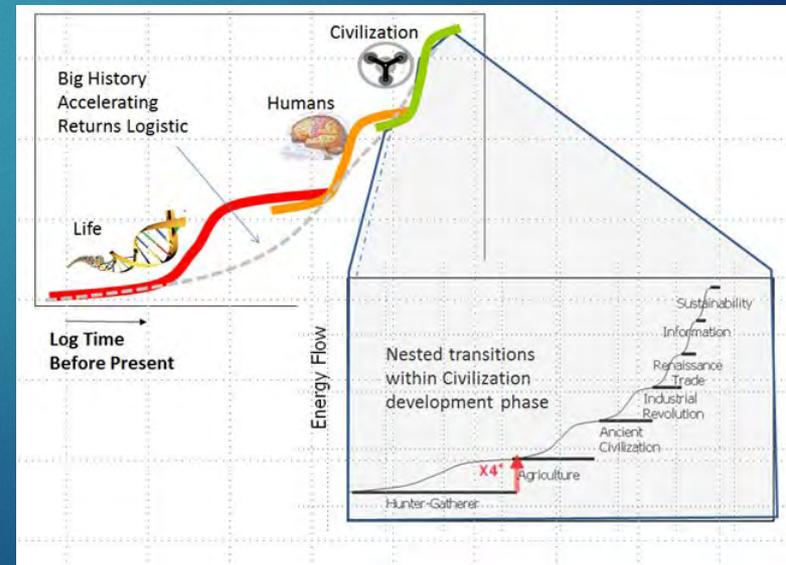


Contributions

- ▶ Complex Adaptive System
 - ▶ Energy/Environmental patterns
 - ▶ Combined accelerated learning and logistic learning pattern
 - ▶ Indications and implications of slow down
- ▶ Worked in High Energy Physics, Holographical Optical Traps, Neutron moderation, Environmental modeling, Nuclear detection, Information systems transitions



D.J. LePoire, "Potential Nested Accelerating Returns Logistic Growth in Big History", in "Evolution: From Big Bang to Nanorobots", Editors: Leonid E. Grinin and Andrey V. Korotayev, Uchitel Publishing, Volgograd Russia, 2015.



References

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- ▶ Carr, B.J. and M.J. Rees, 1979, The Anthropic Principle and the structure of the physical world, *Nature*, Vol 278, 12 April.

