

Cosmic Embryogenesis

Presented in the Embryo Physics Course <http://www.embryophysics.org>

February 3, 2010

By

Clément Vidal

Centrum Leo Apostel (CLEA)

Evolution, Complexity and Cognition (ECCO)

<http://clement.vidal.philosophons.com>

Clement.Vidal@philosophons.com



Cosmic Embryogenesis



Clément Vidal

Vrije Universiteit Brussel, Belgium

Centrum Leo Apostel (CLEA)

Evolution, Complexity and Cognition (ECCO)

<http://clement.vidal.philosophons.com>

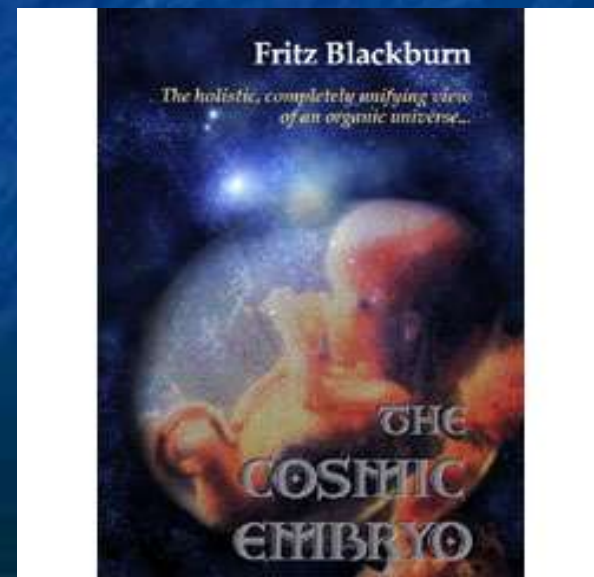
Introduction

Who are you?

- Could you please type **keywords** with your background and current research interests?

Who am I?

- Background in philosophy, logic, cognitive sciences
- NOT New Age!
 - "It shows how God, sex and genetics relate to the Form of the universe. "
 - But speculative philosophy



The Evo Devo Universe (EDU) project

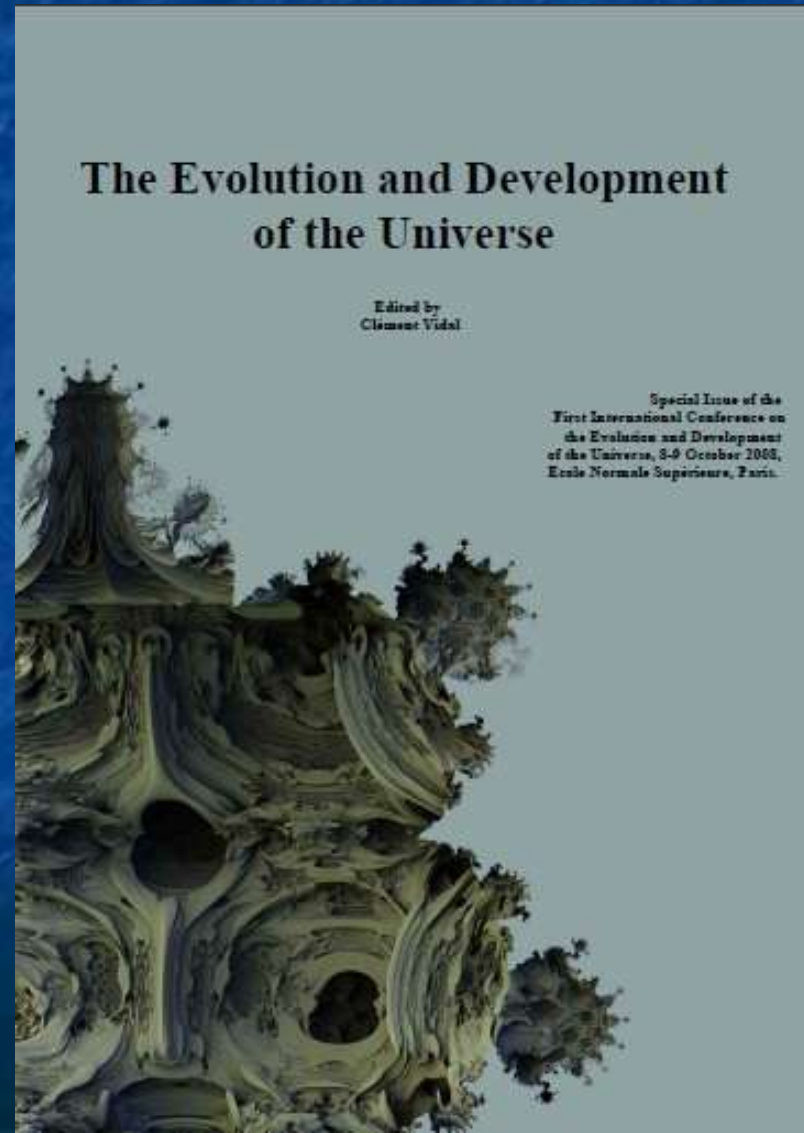
- Cosmology is a part of theoretical physics.
- Poor connections with life, intelligence and technology.
- EDU: broader framework to understand our universe with insights from :
 - evo devo biology
 - complexity sciences
 - etc.



www.evodevouniverse.com

Evo Devo Universe wiki (1/2)

- Peer-reviewed papers, commentaries and responses in physics, cosmology, biology, philosophy.
- 355 pages
- The Evolution and Development of the Universe. *Foundations of Science*, Special Issue of the Conference on the Evolution and Development of the Universe, Ecole Normale Supérieure, Paris 8-9 Oct., 2008.
- <http://arxiv.org/abs/0912.5508>



Evo Devo Universe wiki (2/2)

- Bibliography
- List of 45 interdisciplinary researchers
- Discussion list, research questions, etc.
- You are welcome to visit and join!
 - www.evodevouniverse.com

Outline

- 1. Research problem
- 2. Towards simulations of the universe
- 3. Cosmic embryogenesis
- 4. What occurs between big bang and heat death?
- 5. Open Questions

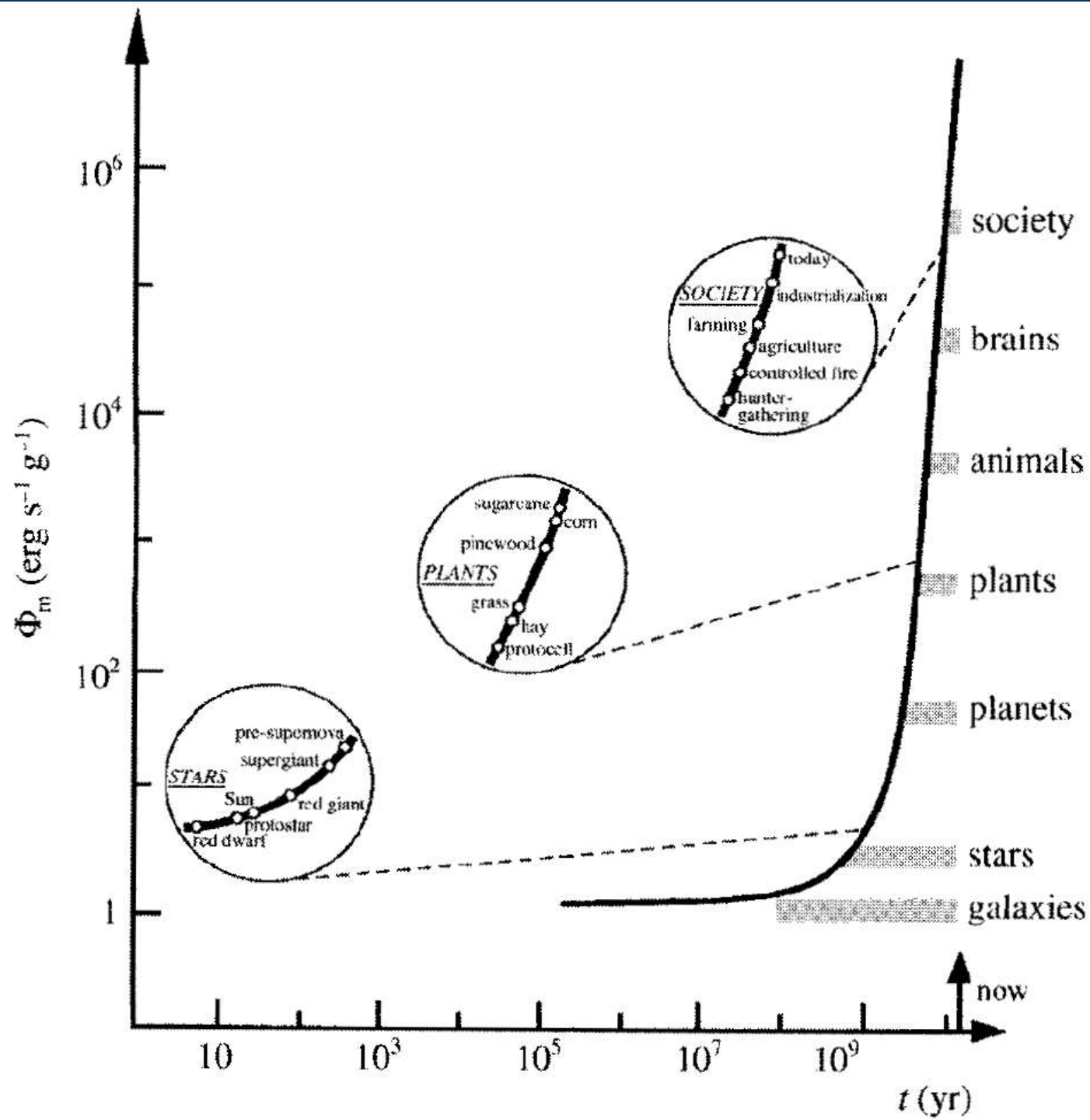
1. Research problem

Two opposite trends in cosmic evolution

- **Increase in disorder:** second law of thermodynamics
 - Leads to heat death and intelligent life is doomed!
- **Increase in order, complexity**
(Kurzweil 2005, Morowitz 2002; Livio 1999)
 - Nobody knows where it leads

Questions

- Which trend will dominate in the long-term?
 - One of the most exciting scientific questions.
- Is there a development at play at the universal scale?
- Let us explore the complexity increase.



2. Towards simulations of the universe

Cosmology is a peculiar science

- One single object of study
- Thesis A1: **The universe itself cannot be subjected to physical experimentation.**
 - We cannot rerun the universe with the same or altered conditions to see what would happen if they were different, so we cannot carry out scientific experiments on the universe itself.
- Thesis A2: **The universe cannot be observationally compared with other universes.**
 - We cannot compare the universe with any similar object, nor can we test our hypotheses about it by observations determining statistical properties of a known class of physically existing universes. (Ellis 2005)
- Re-running the tape of the universe?

Limits of modelling

- Life forms builds more and more extended models of their environment.
 - "An important characteristic attributed to conscious beings is the ability to form internal models of the world they experience; the greater the consciousness the more complex the models."
- (Russell 1982, 83)
- What is the limit of this evolutionary trend?

Exponential increase in computational resources

- Moore's law
 - Increase in : processing speed & memory capacity.
- To the limit:
 - Black hole “computer” (Lloyd 2000)
 - We have computational resources to simulate a whole universe (Vidal 2008)

"Real-world" simulation of our own universe

- As if we biologists were working with clones only!
- We need to explore the space of physical parameters.

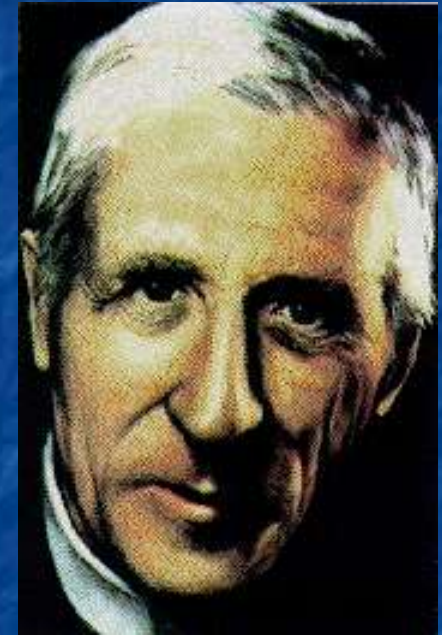
ALife and ACosm

- **Artificial Life (ALife)**
 - Study possible life forms
- **Artificial Cosmogenesis (ACosm)**
 - Study possible universes (Vidal 2008)
 - See also Cirkovic "Sailing the Archipelago" (in preparation). "

3. Cosmic embryogenesis

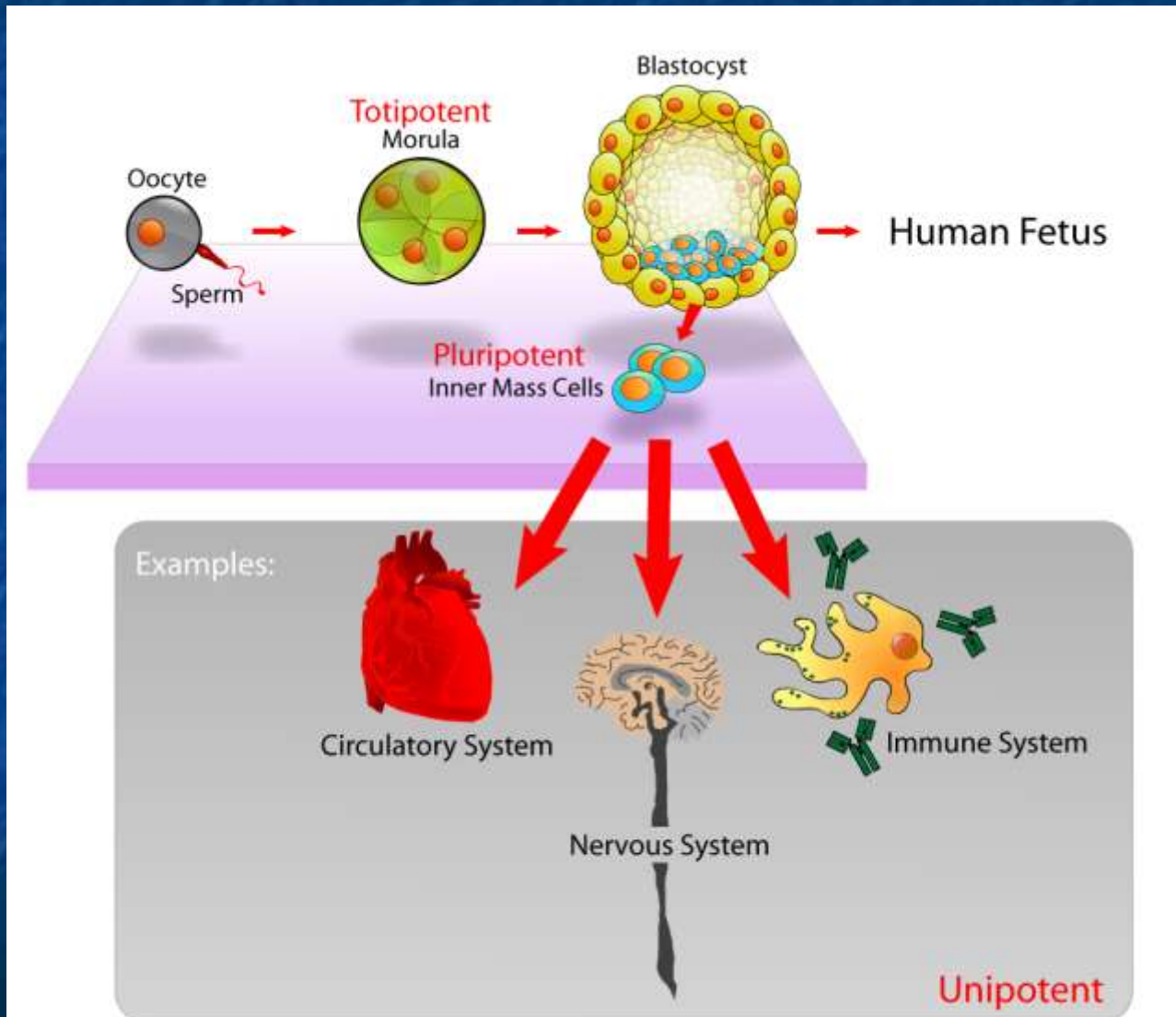
Introduction of the term

- “Cosmic Embryogenesis”,
Teilhard de Chardin (1955, 68).
- Geogenesis
- Biogenesis
- Noogenesis
- (What next?)



**Pierre Teilhard de Chardin
(1881-1955)
Paleontologist
Jesuit Priest**

Differentiation in embryology (cell types)



“Differentiation” of Atomic elements

- Early universe nucleosynthesis
 - Protons & Neutrons form atomic nuclei
 - Atoms form from nuclei and electrons
 - Light elements nucleosynthesis (Hydrogen, Helium)
 - See (Weinberg 1977) *The first three minutes*

■ Stellar nucleosynthesis

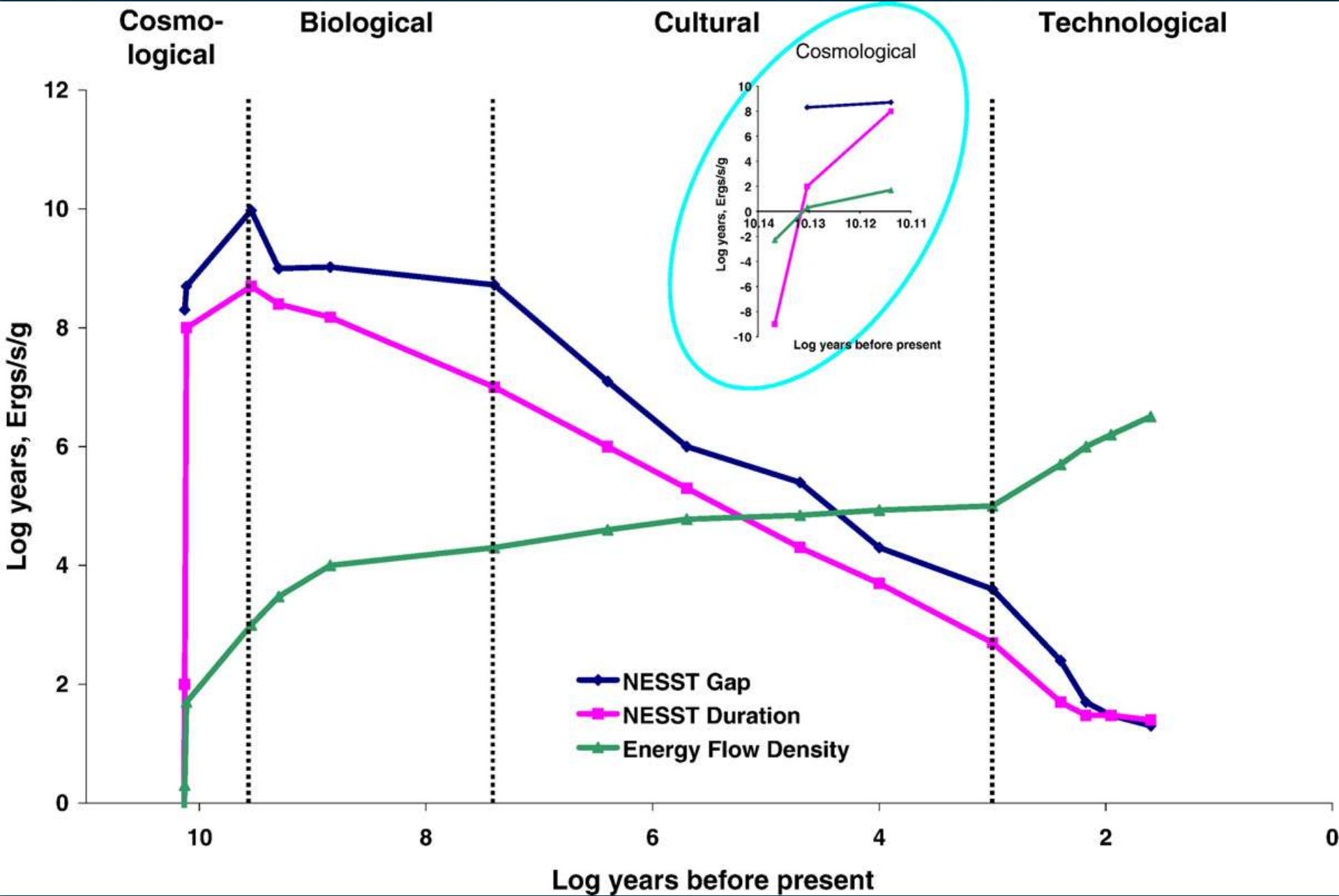


The origin of life: its cosmic significance (Aunger 2007)

- The origin of life is the inflection point :

From **deceleration** to ...

acceleration of evolutionary transitions.



The universe and its replicative transitions

- **Biological:** vertical replication
- **Cultural:** horizontal replication
- **Technological:** machine-machine replication

(Aunger 2007); see also (Dawkins 1995)

Summary of cosmic embryogenesis

Cosmology

Big Bang

?

Heat death

Biology

Birth

?

Senescence

What do you think is missing in between? (tip?)³

4. What occurs between big bang and heat death?

Next stage of Augner's **replicative** transitions:

- Biology: vertical replication
- Culture: horizontal replication
- Technological: machine-machine replication
- **Cosmological:** universal replication
 - e.g. Cosmological *Natural* Selection (Smolin 1992),
Cosmological *Artificial* Selection (Vidal 2008, Vaas
2010), Developmental Singularity (Smart 2008).

Reproduction

- Organisms generate eggs, which are blueprints of themselves.
- What would be a blueprint of the universe?
 - The universe generates (via intelligent life) a simulation of an entire universe, which is a blueprint of itself.

The Phenomenon of Science

- What does scientific activity means from a cosmic viewpoint?
- The contemporary generation of scientists constitutes 90 % of all the scientists who have ever lived on Earth
- "The growth rates of population, production, and science are roughly in the ratio 1:2:4"

Future of an evo devo universe

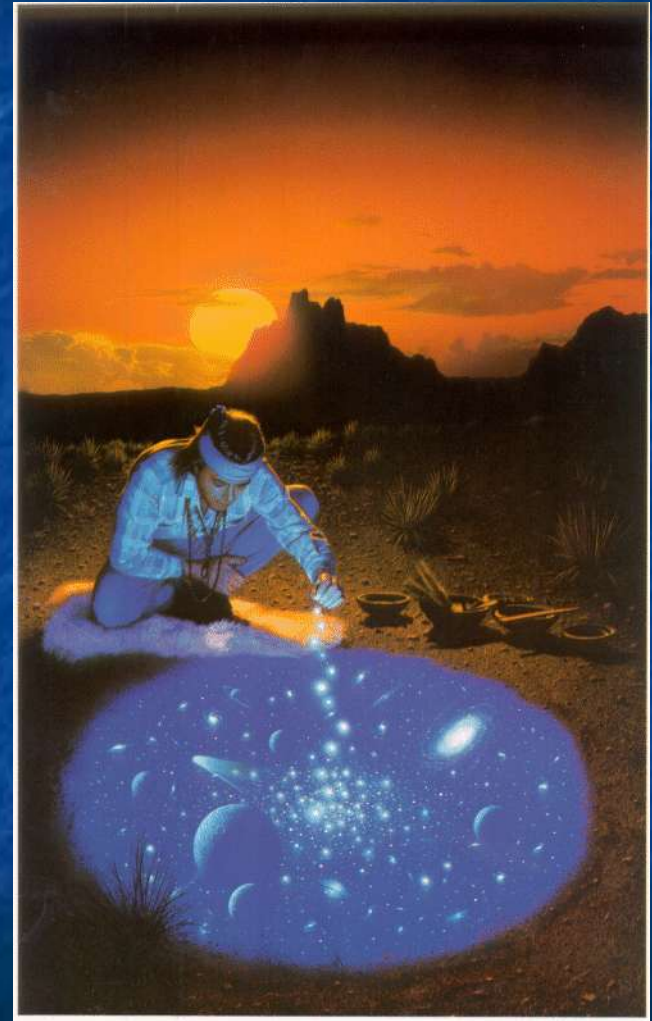
- Disposable soma theory of aging (Kirkwood 1999)
 - Trade-off of resources dedicated to
 - Soma (maintenance)
 - Germ-line (reproduction)
- If science is building the germ-line of the universe.
 - For the successful future of the universe, intelligent civilizations need to invest in science!

Summary & Conclusion

- Between the birth and the death of the universe (big-bang to heat death), there is room for complexity increase.
- The limit of scientific activity is a simulation of an entire universe.
- The metaphor of “Cosmic embryogenesis” misses a fundamental function of living entities: **reproduction.**
- A simulation of an entire universe can be seen as a blueprint (germ-line) for universe reproduction.
- If what I presented makes sense, science is on its way to replicate the universe!

Thank you for your attention!

- Questions, suggestions and criticisms are welcome!



5. Open questions

Fundamental questions for a future developmental cosmology

- How do universal structures differentiate from the big bang?
 - at the right time?
 - in the right place?
 - into the right kinds?

Energetic view

- We saw deceleration and acceleration of transitions.
- Can we precise this argument from an energetic point of view?
- Is there a “U curve”?

Which biological model for the development (and reproduction?) of the universe?

- What constrains the reproduction of the universe?
- Non sexual reproduction?
 - Cosmic embryogenesis or more general epigenesis?
 - Moulting?
- Sexual reproduction?
 - parthenogenesis?

Embryogenesis simulations?

- Is there a sensitivity to initial conditions?

Intelligent life and reproduction

- Is our universe getting adult?
- "intelligent life is the reproductive organ of the cosmos" Gardner 2007

Are there equivalent of "Hox genes"
in the development of the universe?

Bibliography (1/2)

- Aunger, Robert. 2007. A rigorous periodization of 'big' history. *Technological Forecasting and Social Change* 74, no. 8 (October): 1164-1178. doi:10.1016/j.techfore.2007.01.007.
- Chaisson, E. J. 2001. *Cosmic Evolution: The Rise of Complexity in Nature*. Harvard University Press.
- Dawkins, R. 1995. *River out of Eden: a Darwinian view of life*. Basic Books.
- Ellis, G. F. R. 2007. Issues in the Philosophy of Cosmology. In *Handbook in Philosophy of Physics*, ed. J Butterfield and J Earman, 1183-1285. Elsevier. <http://arxiv.org/abs/astro-ph/0602280>.
- Gardner, J. 2007. *The Intelligent Universe: AI, ET, and the emerging mind of the cosmos*. New Page Books, p128.
- Kirkwood, T. B. L. 1999. *Time of our lives: The science of human aging*. Oxford University Press, USA.
- Kurzweil, R. 2006. *The Singularity Is Near: When Humans Transcend Biology*. Penguin Books.
- Livio, Mario, and Mario Livio. 2000. *The accelerating universe*. New York, Wiley & Sons.
- Lloyd, S. 2000. Ultimate Physical Limits to Computation. *Nature* 406: 1047-1054. http://www.hep.princeton.edu/~mcdonald/examples/QM/lloyd_nature_406_1047_00.pdf.
- Morowitz, Harold J. 2002. *The Emergence of Everything*. Oxford, Oxford University Press.

Bibliography (2/2)

- Morowitz, Harold J. 2002. *The Emergence of Everything*. Oxford, Oxford University Press.
- Russell, P. 1982. *The Awakening Earth: The Global Brain*. Ark.
- Smart, J. 2008. Evo Devo Universe? A Framework for Speculations on Cosmic Culture. In *Cosmos and Culture*, ed. S. J. Dick. To appear. <http://accelerating.org/downloads/SmartEvoDevoUniv2008.pdf> .
- Teilhard de Chardin, P. 1955. *Le phénomène humain*. Paris. Seuil.
- Turchin, V. F. 1977. *The Phenomenon of Science*. New York: Columbia University Press. <http://pespmc1.vub.ac.be/POS/TurPOS.pdf> .
- Vaas, R. 2010. Life, the Universe, and almost Everything: Signs of Cosmic Design? 0910.5579. <http://arxiv.org/abs/0910.5579>
- Vidal, C. 2008. The Future of Scientific Simulations: from Artificial Life to Artificial Cosmogenesis. In *Death And Anti-Death*, ed. Charles Tandy, 6: Thirty Years After Kurt Gödel (1906-1978).:285-318. Vol. 6. Ria University Press. <http://arxiv.org/abs/0803.1087> .
- Vidal, C., ed. 2009. *The Evolution and Development of the Universe*. Ecole Normale Supérieure, Paris 8-9 Oct., 2008: in press, Foundations of Science, Special Issue of the Conference on the Evolution and Development of the Universe, 355p. <http://arxiv.org/abs/0912.5508> .
- Weinberg, S. 1977. *The First Three Minutes: A Modern View of the Origin of the Universe*. Basic Books.