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EXPANSION SCENARIOS

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Mathematics, the 'language' of Nature, is most elegantly expressed in the physics and behavior of complex, chaotic systems, of which intelligent life is the paramount example.

Intelligence may be a powerful factor in shaping the long-term evolution of the universe. The cosmological constants that precipitated the formation of complex carbon chains – and hence life – effectively predestined its expansion into the cosmos¹. Over the long-term, this expanding wavefront will inevitably affect the long-term evolution of the universe itself.

The migration of intelligent life into the cosmos is not an option; it is an imperative. Any local population is potentially threatened by a multitude of dangers: asteroid impacts, gamma-ray bursts, and depletion of natural resources are but a few of the examples². In order to confront these uncertainties more readily, we must be bold enough to leave the womb of the earth and challenge the vast expanses of space.

Evolution of Life at the Cosmic Scale

Consciousness may exist not only as a passive participant in the backdrop of the evolution of the universe; it may be capable of influencing its very fate through conscious design. Locally, this possibility may be mediated through the role of consciousness in the process of wavefunction collapse³. Instances of more global influence include the engineering of 'basement' universes or the creation of traversable wormholes by Type III civilizations.

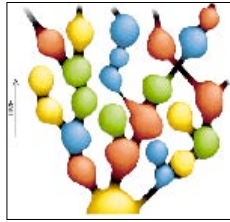
¹ Complex carbon chains, DNA and even simple bacteria can be spread throughout the interstellar medium via asteroid impact common in the early stages of planet formation.

² Bostrom, 2000

³ (Should the Copenhagen interpretation prove to be correct)

A basement universe possesses a fate independent of its parent: harnessing the zero-point energy to trigger inflation becomes a form of *applied cosmological engineering*. And if basement universes are already a naturally occurring phenomenon – as suggested in inflationary models and by Hawking radiation – then the multiverse could take on all the characteristics of an evolutionary algorithm.

Li and Gott speculate that a universe undergoing the rapid early expansion known as inflation could give rise to baby universes - one of which by means of a closed timelike curve would turn out to be the original universe⁴.



Though the parent universe in any branching scenario need not have been of intelligent design, once a suitable set of cosmological constants is found through natural inflation, intelligent life could branch out from this point of origin, forming an expanding wavefront of intelligence and altering the phase space of the multiverse *itself*.

The Expanding Wavefront

Kardashev defines the Stage III civilization as one that has matured to the point of being able to harness and control its own galaxy as an energy source⁵. Once intelligent life matures to this point, it obtains the capability not only to influence its immediate environment, but those of its surrounding systems and beyond.



A potential enabling factor lies in the development of traversable Laurentian wormholes. As shown by Kip, Morris and Thorne: Laurentz- invariant wormholes do not violate the Einstein equations. If wormhole engineering proves feasible at some point in the future, intelligent life would quickly begin

⁴ Peterson 1998

⁵ e.g. the Dyson sphere

branching out into other universes, with complementary cosmological constants. This blossoming of universes with conditions suitable for life would share many characteristics of the Guth inflation model.

Panspermia

Rapid advances being made in science and technology are bringing topics once solely the domain of philosophy into the realm of possibility. How did life arise on Earth? *Panspermia* posits that the dawn of life on earth was not a one-time local event; it originated in space and was brought here to earth, by an event such as an interstellar asteroid impact.

Was life seeded here? And if so, was it through accident or intelligent design? As a potential successor to carbon-based life on earth, silicon-based intelligence will play a prominent role in any transition to space. Si_{12} -based intelligence lacks many of the inherent limitations that constrain C_{16} -based life to the biosphere: software and hardware architectures can be dynamically reconfigured and adapted to match environmental conditions. The flexibility and advantages posed by silicon-based intelligence grant it the potential to act as a powerful catalyst in the dissemination of life throughout the cosmos.

If intelligent life is common and the Stage III civilization is a widespread transition in the progression of intelligence, given the age of the universe and simple probability, other intelligences should already be present. But we seem to be alone. Is there some boundary condition we neglect to account for in our search for life in the universe?

$$N = R_* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

Drake Equation

Given that the conditions of the Drake equation are met, a potential explanation for the silence in our neighborhood of the cosmos is that inter-universe panspermia supercedes local expansion. Vernor Vinge's *Singularity* may not be only technological; it may be physical. The most powerful computer we can imagine would for all intensive purposes resemble a black hole. Space travel may become redundant: once life reaches a sufficient level of development, it may be possible to reconfigure spacetime itself within immediate surroundings.

⁶ At this point technology would be advanced enough to exploit the laws of physics and construct basement universes. It is most likely that this future intelligence would engineer universes with cosmological conditions also suitable for life – these would be the most interesting experimentally.

Do advanced intelligences ‘nurture’ new civilizations to maturity in their spare time? Prof. Nick Bostrom raises the possibility that we may be living in a simulation – that advanced civilizations simulate their own historical development through cosmological scale experiments. But if wormhole engineering becomes possible, these advanced civilizations would have no need to recreate their own past ... they may be able to explore it directly.

Alternate Vectors

Silicon-based intelligence need not be the final stage in the evolution of life. More likely, evolution progresses from carbon, through carbon-silicon composites, to a number of potential alternative encoding substrates that offer greater information compression.

$\square, \square, \square, \dots \square$

Phase transition in intelligence substrates could be common

We cannot neglect alternative vectors in the long-term evolution of life: it is important not to be bound by traditional, digital computational analogies. Carbon-based life may harness the power of quantum mechanics to attain equilibrium more quickly than would be possible by traditional, von Neumann computation – as evinced by proton tunneling in tertiary protein folding, or by quantum coherence in microtubule structures⁷. More advanced forms of intelligence would most certainly employ the advantages presented by harnessing quantum computation.

Alternate substrates for information processing are myriad and include hybrid or alternative biochemistries, nano- or femto- scale technologies, quantum scale encoding⁸, Dyson spheres, Matrioshka brains⁹, neutron star or black hole computers, or more radical encoding schemes such as quantum foam¹⁰, string tunneling or other, as yet undiscovered matrices.

Could traversable wormholes form an interstellar, or inter-universe, communications network? The discovery and application of yet unknown physics remains a distinct possibility¹¹ – are there subtle connections with wave-particle duality, e.g. through the manipulation of spacetime geometry

⁷ Hameroff, Penrose, Satinover, Tuszynski

⁸ Including quantum teleportation, entanglement and coherence

⁹ Matrioshka brain [summary](#)

¹⁰ Planck-scale qubits

¹¹ Bohm’s pilot wave model; superstring theory

itself via nonlocal interaction¹²? How would superstring theory interface with the physics of an advanced intelligence?

The potential havens for life may extend to the multiverse: encoding consciousness in quantum foam, harnessing traversable wormholes as a ‘superhighway’ to parallel universes, discovering untapped dimensions at the higher energy levels of superstrings. Life need not be constrained to any isolated, or finite, system: the singular drive for survival may fuel the transcendence of space and time itself.

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¹² Bohm, EPR entanglement, Bell inequalities