

BIOCOSMOLOGY: REIMAGINING LIFE'S PLACE IN THE COSMOS

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Three new papers to be released on April 21st by a team of physicists and biologists create a new vision for bringing living biosystems into the framework of fundamental physical laws, with far-reaching implications for how we view our planet within its cosmological context. Cosmologists Marina Cortês and Andrew Liddle from Lisbon, biologist Stuart Kauffman from Seattle, and physicist Lee Smolin from Waterloo, Canada, have been working for three years to bring to fruition the vision of a new scientific discipline, which they name Biocosmology, that brings modern thinking about biological systems into a physical, and even cosmological, context. Their publication commences that journey.

“Our goal was to be able to discuss biological systems on the same footing as physical systems, to interpret our biosystem using the currency of the cosmos” said team member Marina Cortês, who first introduced these ideas during a seminar at the Perimeter Institute in Canada in late 2019. “It turns out we had to rethink everything, challenging even the reductionist assumption of physicists which says systems are best understood by breaking them into their constituent parts.”

Copernicus set us adrift, spinning around a random star in a random galaxy among hundreds of billions of galaxies, each with hundreds of billions of stars. Cosmology starts with Einstein's General Relativity, 1915, in a fixed universe, and brings us to the highly detailed modern science of our Universe, discovered first to be expanding by Edwin Hubble and later even to be accelerating. Huge observational projects and supercomputer calculations verify the many successes of cosmological modeling.

And yet “the more we know of the universe, the more meaningless it appears”, said Stephen Weinberg, Nobel Laureate, in 1995. The meaningless universe ignores the life that teems on at least our planet, Earth. We are Darwin's “tangled bank”, “Froth, flute, fin, and quill at the wood's dancing hoof”, as Welsh poet Dylan Thomas wrote. Nowhere in the one-hundred-year-old history of Cosmology does the fact of the existence of life enter the story. The tangled bank is irrelevant in the vast swirl of stars. When we account for the Universe, life is nowhere on the ledger.

The new papers report the first, and stunning, evidence that this standard view of Cosmology is, to put it bluntly, wrong. We will have to think – and count - again. The way to demonstrate this claim is to count up how complex the total universe is without life, and to count up how complex is just our own planet Earth.

The key idea here is The Adjacent Possible (TAP), introduced by team member Stuart Kauffman in 2008. “What can happen next, the adjacent possible, depends on what we already have”, says Kauffman. “Innovations, be they biological or technological, come from combining existing items to create novelty. These can then be tested in the arena of evolutionary selection. Not only can one not deduce in advance what path biological systems will follow, one cannot even say what possibilities exist until they are actualized.” Unlike in physics, in biology the `state space' of possible configurations is continuously and unpredictably growing. What might this mean for our role in the cosmos?

The results startled the team. The complexity of the entire “abiotic universe” without life is known to be a huge number. In detail the number is $(10^{(10^{124})})$, the number 1 with 10 to the 124th power zeros after it. Even if you could write a zero on every atom in the visible Universe you would have nowhere near enough to even just write this number!

Can the life on one tiny planet compete with such a vast cosmic complexity measured without life? Incredibly, yes! The complexity of life with Darwin’s Tangled Bank, even considered long ago at the very onset of life 3.7 billion years ago, is *vastly larger*. In a particular computer simulation, at the start of the RNA world early in life’s evolution, the scientists already found a complexity of $(10^{(10^{237})})$, greatly exceeding the cosmological number. Other simulations have yielded yet larger numbers and even towers of exponentials.

Driven by the power of the Adjacent Possible, the creativity of the biosphere and its expanding state space can overwhelm the cosmological state space. We have the first objective measurement of the complexity of life on our planet compared to the entire Cosmos. Froth, flute, fin, and quill dwarf the hundreds of billions of galaxies with their hundreds of billions of stars, plus black holes, plus dark matter and dark energy.

Biocosmology allows us to see life through the lens of black holes, dark energy, and dark matter. It is the first quantification, ever, of the value of our planet before the vastness of the cosmos. If the abiotic universe is void of meaning, bustling life quivers with it. The origin of life was the origin of meaning. We still do not know how life may have started on Earth 3.7 billion years ago, nor if we are alone, or whether life is abundant in the Cosmos. But life itself, here and abundant, invests the Cosmos with meaning. That is the message of the new science of Biocosmology.

The Biocosmology papers will be launched on April 21st 2022 via live zoom link, featuring team member Marina Cortês at Everest Base Camp, Nepal, where she is on route to an Everest summit climb without supplemental oxygen with the Imagine Nepal team of leading Sherpa climber Mingma G. The event will run twice, first at 09:00 UK (WEST)/13:45 Nepal, and then at 12:00 Eastern/09:00 Pacific.

** Reaching Everest Base Camp carries many uncertainties, especially as Marina will be doing a 19-hour acclimitization climb immediately before the embargo ends. Hence April 22nd is retained as a backup date in case the 21st proves unachievable.

Zoom link for press conference and Q&A with authors:

<https://us06web.zoom.us/j/6135524320?pwd=WFJuaEE0VDFtRHNXcUpmTWNDamJ3Zz09>

Web page for paper download and accompanying materials: <https://www.biocosmology.earth>

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