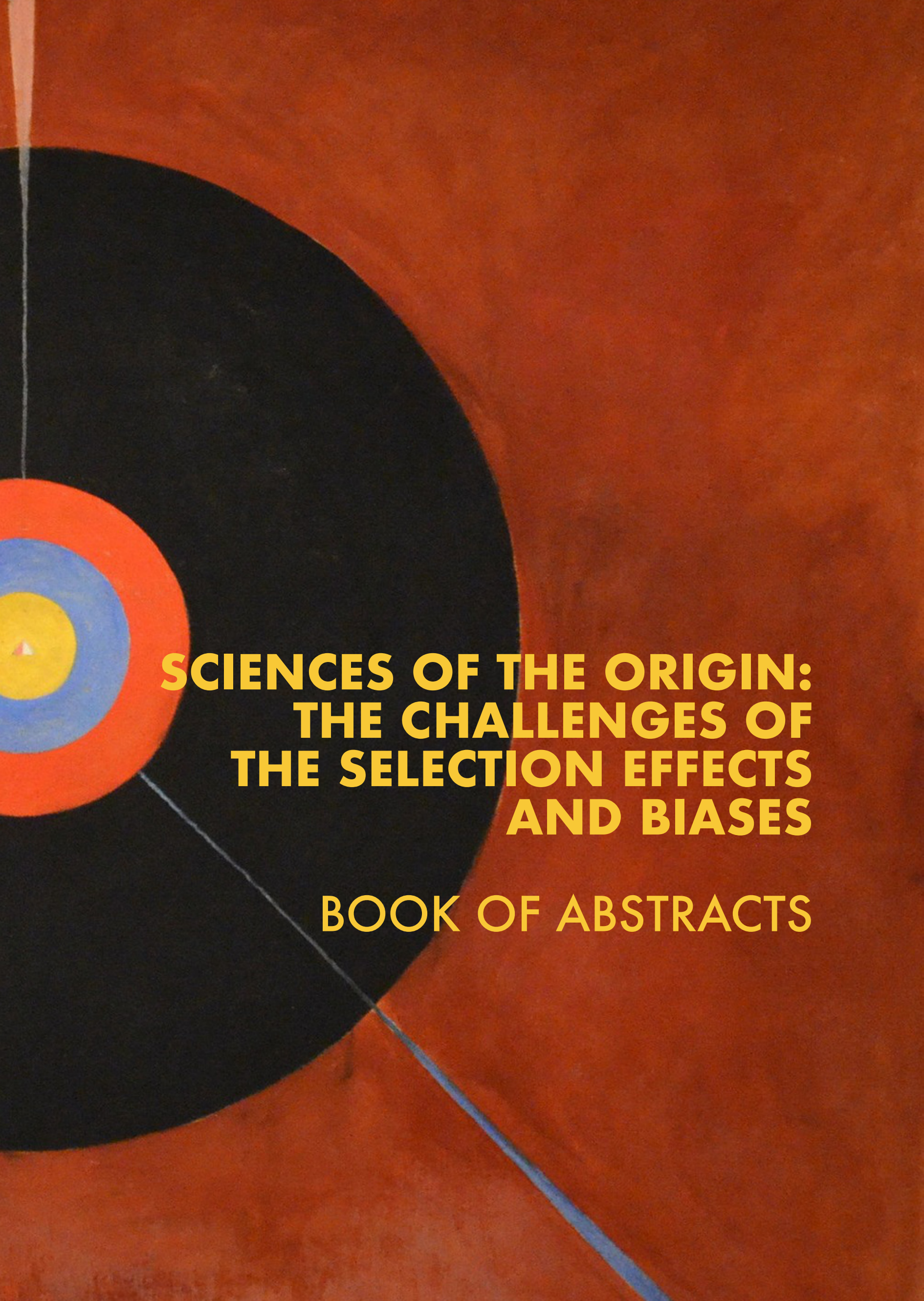

SCIENCES OF THE ORIGIN: THE CHALLENGES OF THE SELECTION EFFECTS AND BIASES

BOOK OF ABSTRACTS

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SCIENCES OF THE ORIGIN: THE CHALLENGES OF THE SELECTION EFFECTS AND BIASES

BOOK OF ABSTRACTS

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1.

CONCEPTUAL BIASES IN THE SCIENTIFIC EXPLANATION OF ORIGINS

KEYNOTE

Adrian Currie
University of Exeter, United Kingdom

ORIGIN-NARRATIVES: FINS, FEET & FOIBLES

An origin-narrative seeks to provide a sequence of events leading to some important, putatively-unique phenomenon. They explain how we got from a world without said phenomenon, to one with it. Science, particularly historical science, is replete with examples of origin-narratives: the evolution of our own species, the rise of various cultural institutions, the birth of the universe. Another concerns the origin of the foot. It was the foot that enabled tetrapod vertebrate lineages' adapting to terrestrial life; having feet enabled extraordinary radiations. To explain the foot, we must understand the morphological and ecological factors that underpinned its evolution. To understand this, we need to understand fins. After all, pectoral fins are a precursor to, a step on the way, to evolving feet. So, a critical part of the origin-narrative of the tetrapod foot is the pectoral fin.

There is nothing wrong in principle with origin-narratives, but in practice there are several closely-knit foibles associated with them. First, linearity. The structure of a story often takes on the form of a series of steps and choice-points which take us from, in this instance, a footless world to one replete with them. But, we might worry, history is often complex, too complex for a simple linear narrative. Second, direction: the linearity of an origin-narrative often frames the steps taken as steps towards the outcome. There is a tendency to see earlier steps as forerunners to later steps. But history is sometimes too contingent to support such directionality. Third, narrative-significance: what is significant about those steps and choice-points—phenomena unto themselves—is their being part of the narrative towards the origin of the thing we're interested in. Understanding pectoral fins is necessary for understanding feet; their being interesting is derivative. Fourth, change-bias, origin-narratives are fundamentally about change, about explaining how things were one way, and became another. But it is also important to understand continuity and stasis.

Particularly when origin-narratives are employed to structure investigations, these foibles can loom large. But these foibles are neither essential or necessary: narratives can accommodate contingency and non-linearity, and we need not think that the sum entirety of what matters is change and narrative significance. Critically, the investigative strategies historical scientists take towards constructing and testing origin-narratives can lead us from simple, linear stories to complex, integrated and open-ended investigations. I'll explain some of these strategies and show how they mitigate the foibles of origin-narratives.

Cyrille Jeancolas
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THRESHOLDS IN ORIGIN OF LIFE SCENARIOS

Thresholds are widespread in origin of life scenarios, from the emergence of chirality, to the appearance of vesicles, of autocatalysis, all the way up to Darwinian evolution. Here, we analyze the "error threshold," which poses a condition for sustaining polymer replication, and generalize the threshold approach to other properties of prebiotic systems. Thresholds provide theoretical predictions, prescribe experimental tests, and integrate interdisciplinary knowledge. The coupling between systems and their environment determines how thresholds can be crossed, leading to different categories of prebiotic transitions. Articulating multiple thresholds reveals evolutionary properties in prebiotic scenarios. Overall, thresholds indicate how to assess, revise, and compare origin of life scenarios.

Craig W. Fox
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THE END OF THE BEGINNING? ON A METHODOLOGICAL TENSION IN EARLY UNIVERSE COSMOLOGY

I am concerned about a potential methodological tension in early universe Cosmology. In particular, I am concerned with the employ of the so-called dynamical systems approach to resolving the apparent fine-tuning of the universe's initial state. I will show that solutions such as inflation—my argument applies, as well, to many of inflation's competitors—undermine the motivation for doing cosmology. More specifically, inflation solves the fine-tuning problem by erasing the very contingency that is necessary for using astrophysical observations to probe Planck regime physics.

Evidently, in order to have a universe anything like the one we now observe, the initial state could have differed from what it was by no more than about 1 part in 10^{120}, by some estimates. Moreover, this value is thought to be incredibly unlikely, and so the fine-tuning problem is looks to be a pressing problem indeed. Inflation comes to the rescue, by positing an attractor dynamics. The inflaton field drives exponentially accelerated expansion of the early universe, which eliminates dependence on an unlikely initial state, giving an elegant and parsimonious answer to the fine-tuning problem.

The tension that I'm worried about concerns an important aspect of cosmology, viz. that it is an investigation of the past. Reflecting on historical investigations, it's clear that, on the one hand, contingency—in the sense of sensitive dependence of later states on earlier ones—adds to the complexity and uniqueness of history. And it is just this that high energy physicists are trying to eliminate. On the other hand, contingency is an epistemic blessing, for only when the present sensitively depends on the past is the present a source of empirical constraints on theories concerning the past. Nature does not always cooperate, in this regard, as information loss is common. But when she does cooperate, contingency is an epistemic blessing. When information loss has not dashed all epistemic hopes of knowing the past, the degree of sensitivity on earlier states grows rapidly the further back in time one probes.

From this perspective, the apparent fine-tuning of the initial state is surprising in what it tells us, but is an epistemic bounty the likes of which historical scientists dream. Given that one of the primary motivations for doing cosmology is to use astrophysical observations to probe energy scales vastly beyond those experimentally accessible, nature has bestowed upon cosmologists an incredible epistemic gift. If the motivation for doing cosmology is to probe Planck regime physics, sensitive dependence on the state of the universe at Planck time is crucial. But inflation undermines all fo this. Its touted success is that the universe could have had any initial state whatever, and inflation will drive the system into a state compatible with what we observe. Inflation, then, makes the later state necessary and erases contingency by diluting everything prior completely away. Inflation, then, pulls the plug on the poor man's accelerator too soon, cutting off access to the Planck regime. It therefore undermines the motivation for doing early universe cosmology in the first place.

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ORIGINS

Some of the most successful scientific discoveries that overhauled received beliefs about the past were of origins. Darwin's discoveries of the origins of species are the most obvious examples. But other important discoveries of origins include the discoveries of the origin of the universe, the Big Bang; the origin of the continents, the supercontinent Pangea and the drifting continental plates; the African origin of humanity and the origin of non-Africans in interbreeding with Neanderthals; the common origins of language families such as the Indo-European languages, and so on. Though the inferences of origins changed historical consciousness and orientation in time, discussions of origins are missing from metaphysics, epistemology and the philosophy of science.

This article analyzes the metaphysics and epistemology of origins. Origins are information sources that transmit encoded information signals to receivers. These receivers may be decoded to infer their origins or some of their properties. Information as reduction in uncertainty fits the metaphysical assumptions and epistemic practices of the historical sciences that infer origins including Cosmology, Phylogeny, Geology, Historical Linguistics and Historiography. I demonstrate that information transmission and causation are metaphysically and epistemically distinct and irreducible to each other, despite partial overlapping extensions. I demonstrate the distinctions between origins and causes by comparing origins with causation according to the major theories of causation, without arguing for or against the theories of causation. Theories of causation are useful as foils to highlight the conceptual, metaphysical, and epistemic distinctiveness of origins. Metaphysical and epistemic theories of origins are simpler and less challenged by counterexamples and counterintuitive results than comparable theories of causation. Consequently, the substitution of origins for causes may simplify and clarify some philosophical problems associated with causation and facilitate their solutions.

Origins transmit information signals that receivers preserve. Effects do not always preserve information about their causes. Origins and receivers are exclusively tokens. Causes and effects are types or tokens. The relation between origins and receivers does not depend on type-type regularities or contiguities because receivers preserve information transmitted from their origins. Receivers can preserve information to different degrees. The distinction between origins and mere conditions of receivers is easier to make than the distinction between causes and conditions, and is value free. The *information* that nests in receivers is conditional on their origins. The *existence* of receivers is conditional on other conditions, including causes. These differences allow the metaphysics and epistemology of origins to avoid similar challenges to those that theories of causation have had to face.

Mihajlo Stamenković
University of Belgrade & University of Novi Sad, Serbia

THE MULTIPLE DYNAMICAL SYSTEMS APPROACH TO LANGUAGE EVOLUTION

We would like to present a contemporary interdisciplinary methodology of linguistic investigation as subscribed to by Simon Kirby and other prominent researchers in the field (Thomas Griffiths, Kenny Smith, Andrew Smith and Morten Christiansen, among others). It tackles the problem of origin and development of the language faculty and the structural systematicity of linguistic performance. It does so through the examination of multiple systems involved in enabling the linguistic transmission of semantic information – which simultaneously emits the information about the way language is constructed. These systems are dynamical because the transmission of information (which they facilitate) over time results in change of the information being transmitted. Language is here conceived to emerge and to change due to the nontrivial interactions between three complex adaptive systems operating on very different timescales: 1) biological evolution by the process of natural selection, 2) cultural transmission through the process of iterated learning and 3) individual learning constrained by the social language transmission and use bottleneck selection pressure and by the prior (linguistic) learning bias. This approach draws heavily on computational or mathematical models of populations of individuals, referred to as agents, each embodying the basic learning mechanism under study – in order to extract indirect evidence for the plausible explanation of the manner by which language had evolved. Models of agents vary from simple mathematical idealisations through abstract computational simulations to physical instantiations in real robots. Conditions used in these models are also being recreated in the laboratory experiments with artificial language acquisition and transmission by the human participants – only to produce findings that converge with those acquired from the models and the simulations. There are suggestions for events in the real world that correspond with the process of this kind (Nicaraguan Sign Language, for example). All of the above makes it a research platform worth studying and pursuing.

Celso Neto, Letitia Meynell, Christopher Jones

Dalhousie University, Canada

SCAFFOLDING: ARTICULATING PROCESS IN SCIENTIFIC EXPLANATIONS

Perhaps the central challenge for any scientific account of origins is to explain how novel phenomena can emerge from something else. This fundamental puzzle can be seen in a wide variety of sciences. Even within the life sciences, it captures questions that range from “how does a child develop a distinct new skill or capacity?” to “how did multicellularity arise?” In this presentation, we will argue that what we call scaffolding explanations provide a distinctive form of explanation that is well-suited to answering questions about how novel phenomena can emerge from other quite different phenomena.

While scaffolding explanations have been employed in the sciences for some decades, how exactly they work is far from clear. They first became prominent in development psychology, where it describes a process in which agents use elements of their environment to accomplish a task that would be difficult to attain otherwise (Wood et al. 1976). More recently, scholars have applied this idea to various evolutionary contexts, ranging from cultural evolution (Wimsatt and Griesemer 2007; Carporael et al. 2014) to the emergence of multicellular life (Black et al. 2020; Doulcier et al. 2020). While these uses of scaffolding are certainly evocative, it is not clear how they are different from other evolutionary explanations that do not employ the term.

In our presentation we will explicate the notion of scaffolding by identifying a generic explanatory strategy shared by developmental psychologists and evolutionists. Our hope is that by clearly articulating this distinct explanatory strategy we might not only clarify what scientists mean when they talk about various phenomena “being scaffolded” or “scaffolding” various other phenomena, but we might also lay bare its tacit structure and relation to other types of explanation (Calcott 2008; Godfrey-Smith 2009; Brown 2014). Clearly articulating the essential structure of scaffolding explanations appears like a necessary first step for developing criteria by which to judge them significant, useful, or sound.

The basic thread of scaffolding explanations is that an object or system is transformed through interaction with an independent set of (typically) environmental resources in a specific concatenation—a scaffold—that initiates and maintains a scaffolding process, which redirects the object or system toward an outcome that otherwise it would have been unlikely or unable to achieve. Such an outcome is often transformative, providing the object or system with novel features or capacities; permanent, when the new state of the object or system can be endogenously maintained once the scaffold is removed; and facilitative, when it provides causal opportunities that may include further transformations by the imposition of new scaffolding resources. In some areas, such as organic development, cascades of scaffolded transformations are ubiquitous. However, the full scope of this explanatory strategy in biology is yet to be seen. We are particularly interested in evolutionary explanations, where scaffolds might be used to explain the emergence of new levels of selection or major transitions in evolution.

Andrew Richmond
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HOW COMPUTATION EXPLAINS

This paper explores issues in the metaphyics of mind, and in our current attempts at an interdisciplinary approach to it.

The 20th century saw a monumental shift in our understanding of the mind, triggered by computational cognitive science — the use of tools, concepts, and formalisms from the computer sciences to explain the brain. As a result, there is a widespread belief that minds are computers, that having a mind is having a computational structure of a certain type. After all, computational cognitive science seems to assume or posit that the brain is a computer, and it does so precisely in order to explain the brain's mental capacities. So identifying the mind with the brain's computational structure seems to be a plausible interdisciplinary approach to the metaphysics of mind (e.g., see Chalmers, 2011; Peacocke, 1994; Piccinini, 2015). I argue that this is a mistake, caused by a failure to take the relevant scientific work seriously on its own terms.

Taking that scientific work seriously means looking at the reason computational tools, concepts, and formalisms are explanatory of the brain, and a careful examination reveals that the reason is not that the brain falls into some metaphysical category, COMPUTER. Rather, computational cognitive science is an example of domain transfer — a transfer of tools and strategies from one domain to another, like when private companies borrow NASA's testing procedures for rocket components to test advertising campaigns (Edsel, 2016), or when we use motivational strategies from video games to create more engaging university courses (Miller, 2014). But domain transfers typically make no metaphysical commitments: advertising campaigns are not rocket ships, and university courses are not games. I argue that the same is true of computational notions in cognitive science: they provide a useful set of tools and resources that bring with them no metaphysical commitments whatsoever. This is not to say that the idea of the brain as a computer is "just a metaphor" — it's far more than that. It's a sophisticated set of tools and strategies that are successfully applicable to the brain for good and interesting reasons. But the success of computational cognitive science gives us no more reason to think the brain is a computer than the success of NASA's testing procedures in advertising give us reason to think ad campaigns are rocket ships.

The motivation for the computational metaphysics of mind was that our mentality is explained, in cognitive science, by the brain being a computer of a certain sort, so it is plausible that the mind is that computational structure. But if cognitive science does not explain the brain by assuming that it is a computer of any sort, this motivation is undercut. I suggest two possible next steps for an interdisciplinary philosophy of mind. First, we could look more carefully at what cognitive science actually thinks the brain is: it is at least committed to the brain having a certain causal structure — maybe that's where we could locate mentality. Second, and more radically, we could abandon the search for a metaphysics of mind altogether, accepting that mentality is not to be explained by appeal to any metaphysical category that minded beings belong to.

2.

GENERAL BIASES IN THE SCIENTIFIC EXPLANATION OF ORIGINS

KEYNOTE

Philip Goff
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BIASES AND SELECTION EFFECTS IN RELATION TO COSMOLOGICAL FINE-TUNING

Our best physics seems to suggest that the law of physics and the initial conditions of our universe are fine-tuned for the possibility of life (Lewis & Barnes 2016). That is to say, for life to be physically possible, certain parameters in basic physics – for example, the strength of gravity, or the mass of the electron – had to have values falling in a certain range, and that range is an incredibly narrow slice of the values those parameters might have had. Call this evidence 'fine-tuning.'

Given that universes with life have much greater value than universes without life, fine-tuning would seem to be good evidence for the following hypothesis.

Value-Selection – The values of the finely tuned parameters were selected in order to maximise the possibility of value in the universe.

On the face of it, the claim that fine-tuning supports Value-Selection is justified via fairly straightforward Bayesian reasoning (Collins 2009):

P1: Fine-tuning is much expected on Value-Selection than it is on the negation of Value-Selection.

· The Likelihood Principle – Evidence E supports hypothesis H1 more than it supports hypothesis H2 iff Pr (E|H1) > Pr(E|H2)

· Conclusion: Fine-tuning supports Value-Selection.

There is clearly a selection effect present here: as living creatures, we could not have observed a universe with parameter-values inconsistent with the possibility of life. Many have argued that the presence of this selection effect undermines the inference to Value-Selection, either because it undermines P1 (Sober 2003), or because it ensures that the fine-tuning supports the multiverse hypothesis: the hypothesis that there are very many universes which, between them, exemplify a wide-range of values of the parameters in question (Bradley 2009).

I will argue that, whilst this selection effect is obviously real, there is no good reason to think it could have either of the above impacts on the evidential implications of fine-tuning, and that reflection on analogies would suggest that it does not. I further suggest that the fact that the inference from fine-tuning to Value-Selection is not more widely made is explicable in terms of two cultural biases:

· A cultural bias against teleology, resulting from a long period between 1859 and the mid 1970 in which there was no empirical evidence for teleology.

· A cultural bias in favour of interpreting Value-Selection in terms of traditional theism, a hypothesis which doesn't fit well with other facts about our universe, e.g., unnecessary suffering.

KEYNOTE

Benedikt Paul Göcke
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GOD AS THE ORIGIN OF ORIGINS

The natural sciences presuppose both the existence of the physical universe and its intelligibility. Both presuppositions entail the existence of God. Regarding the existence of the physical universe: The physical universe is contingent. But, if the physical universe could not have been, there must be a non-physical cause of its existence. The non-physical cause of the existence of the physical universe is a necessarily existing being which we call “God”. Regarding the intelligibility of the physical universe: The intelligibility of the physical universe is a contingent feature which the natural sciences cannot account for. But, if the intelligibility of the physical universe is a contingent feature unaccountable by the natural sciences, there must be a transcendent cause for the intelligibility of the universe. This cause can only be God. Therefore, God is the ultimate explanation of both the existence and the intelligibility of the physical universe. God is the origin of origins.

Ragnar van der Merwe
University of Johannesburg

INTRODUCING THE SUBJECT INTO BIG HISTORY: A MASK OF THEORY OVER THE FACE OF NATURE

Big History merges human history, evolutionary biology, cosmology and other historical sciences into one universal history. Big History is a “modern origin story” that aspires to an overarching explication of the world – to a “unified understanding of reality” – while failing to give a thorough account of the nature of subjectivity; we are only told that subjectivity is “summoned by” or “bubbles up from” the brain (Christian 2018). I propose instead that subjectivity overlays the whole of history and science. History and science are always practiced by subjects who (1) cannot strip those parts of their discipline’s factual content that are contributed by the mind from those that are contributed by the world, and (2) necessarily express that content in terms of narratives or theories that are subject imbued. I suggest that this notion of subject and world entwined is suitably articulated by William Whewell and then by pragmatists tacitly influenced by his work.

Like Kant before him, Whewell develops a philosophy of science that aims for a middle ground between realism (a priori rationalism) and anti-realism (a posteriori empiricism). There is no clear-cut separation between subject and object, between theory and fact, between mind and world. Scientific inquiry oscillates between passive reflection and active participation through time. Both theory and experiment play an inseparable role in generating scientific knowledge and therefore truths. Every inquiring act knits subject and world together; “there is a mask of theory over the whole face of nature” (Whewell 1847, I: 24).

For experience pragmatists like Cheryl Misak, the mind does not represent, mirror or copy reality, but neither is reality simply a product of language games. Instead, like Kant, “[w]e impose human categories on experience” and, like Whewell: “[s]ubject and object merge in experience” (Misak 2014: 29). We cannot pry apart our interpretation from the interpreted. We are “interpretative engines” coordinating and merging theory with data in generating knowledge and truth.

In scientific terms, the scientist synthesises theory and data by following the empirical method. Truths are revealed when theory and experiment synchronise harmoniously, i.e. when predictively successful. We can think of the co-evolution of subjective theory with objective experiment as constituting the ongoing, albeit fallibilistic, progression of science. Subject and object coevolve as a function of our best science in action. The same goes for history and therefore Big History: narrative and fact co-evolve in generating historical truths. We cannot separate the narrative subject from the objective facts as Big History purports to do. Instead, the two intimately entwined in producing truths about the past.

J. Brian Pitts

University of Lincoln, University of South Carolina & University of Cambridge

INDUCTION, META-INDUCTION, NATURALISM, AND ORIGINS

At least into the 19th century, students of origins faced the question of how texts and traces. Increasingly it was held (e.g., Buffon) that textual evidence was either redundant or unreliable, making material traces sufficient. Trusting induction, scientists inferred a vastly longer past. The resulting sciences, including cosmology, are successful.

Induction now functions roughly as a demarcation criterion. Thus the justification of induction of considerable interest. As Colin Howson pointed out, Hume's problem of induction remained unsolved in 2000, while its potentially devastating consequences were ignored.

The Feigl-Reichenbach-Salmon pragmatic justification of induction held that no predictive method is guaranteed or even likely to work, but if anything does, induction does, so induction is optimal. This was perhaps the best of the justifications of induction offered during the serious effort through the 1970s, when exhaustion occurred. The short run problem---that science would work, but maybe not any time soon---was largely resolved recently by Gerhard Schurz. Schurz emphasizes Reichenbach's theme that induction is employed at the meta-level of predictive methods in light of their track records. One entertains a priori even esoteric prediction methods (e.g., prophecy), and is said to arrive a posteriori at the conclusion, based on the actual past, that object-level induction (science, the uniformity of nature) is optimal for predictions. Thus one is justified in consulting doctors over witch doctors to get healed, and satellites and d rocks over scrolls to learn about origins.

An apparently novel difficulty is noted for Schurz's argument, related to short-run worries but based on disagreement about the past. Usually the meta-inductive justification assumes the past to be infallibly and uncontroversially remembered. But induction-relevant debates in intellectual history involve (contested) testimony to isolated events. Any serious predictive method will agree with induction most of the time; fortune tellers, prophets, etc., predict only rarely and do not guide, e.g., the design of airplanes. But there exists testimonial evidence for isolated non-uniformities of nature (e.g., miracles, such as someone's being alive after being quite dead). With induction in dispute, such evidence cannot be discarded automatically in the usual rationalist way, as C. D. Broad noted. For those inclined to accept such testimony, meta-induction might support a partly non-inductive/non-uniform method. Reichenbach briefly noted that in principle, clairvoyance might be justified meta-inductively. Schurz takes meta-induction to resolve worldview conflicts between prophecy and science in favor of science. But the dispute about the past implies that meta-induction fails to yield an objective answer to disputes about reported isolated miracles. More seriously, meta-induction might vindicate occasional prophecies as well as (most of) science, depending on one's beliefs about the past. This novel or hypothetical worry is in fact real and ancient: the Stoics defended divination in this fashion.

If meta-induction could justify science-qualified-by-miracles-and-prophecy rather than straight science (given what some take to be the track record), then the basis for investing deep history purely using material traces may have a lacuna. Some possible responses are sketched.

3.

SOCIAL AND BIOLOGICAL ORIGINS

KEYNOTE

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ON THE SOCIAL ORIGINS OF SELF-AWARENESS

The talk will give an account of the social origins of self-consciousness. I will argue that we develop a sense of self through interacting with others. This development involves a gradual transition from implicit to explicit forms of self- and other-representation during which we come to appreciate our own perspective on the world as one among many. On this account, our understanding of self and others should be thought of in terms of skill or knowledge-how, namely knowledge of how to engage in various kinds of social interaction. These interactions shape our sense of self at different levels, from the very basic bodily levels of self-awareness up to the conceptual ability to think about ourselves and take a stance on ourselves and the world. This, in turn, raises important questions regarding self-knowledge and autonomy.

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ARE AMBITIOUS EVOLUTIONARY DEBUNKING ARGUMENTS SELF-REFUTING?

This paper addresses an important issue that has been commonly debated in the recent metaethical literature, namely the epistemic challenge evolutionary debunking arguments (EDAs) pose for evaluative/moral realism.

EDAs claim to undermine the justification of our evaluative beliefs by placing a special focus on their evolutionary origins. Some of such arguments are more ambitious than the others as they try to undermine the justification of all evaluative beliefs, while some of them are targeted only at moral beliefs, and some at a certain subset of moral beliefs.

All EDAs, however, take a common form: they all claim that knowledge of a certain subset of beliefs is improbable, since (1) such beliefs are shaped exclusively by the mechanisms of natural selection and (2) evolutionary processes aim at reproductive success and thus are insensitive to attitude-independent evaluative truths, if there are any. The former is the empirical premise, and the latter is the insensitivity premise. EDAs also have an epistemic premise, namely that if non-naturalist evaluative (or moral) realism, the empirical premise, and the insensitivity premise are true, then we cannot justify the beliefs in question. These three premises constitute the blueprint of any EDA.

A possible response to the challenge is to assert that ambitious EDAs are self-refuting: since ambitious EDAs take all of our evaluative or moral beliefs to be epistemically suspect, they cannot provide independent reason to believe that our evaluative/moral beliefs are debunked by the argument. For example, Street's EDA makes an assumption about epistemic reasons, namely that scientific evidence has the power to undermine our intuitions. But what makes us believe that scientific evidence is epistemically more reliable than our intuitions? It is perfectly possible that having this evaluative claim is also an adaptation. The idea is that if we cannot trust any of our evaluative beliefs, then we cannot trust our beliefs about whether our evaluative beliefs are debunked by the argument.

My aim in this paper is to show how to plausibly respond to such an objection. I argue against Katia Vavova's claim that Street's and Joyce's EDAs target too much and become self- refuting. This is because EDAs are essentially inductive arguments with a probabilistic conclusion, which allows some of our beliefs to be true. For example, the conclusion of Street's EDA allows the possibility that some of our evaluative beliefs turn out to be true, and it follows that these true evaluative beliefs could include some of our beliefs about epistemic reasons, science, mathematics, and so on. Furthermore, the doubt that we might be mistaken in our evaluative or moral beliefs will remain, even if we think that ambitious EDAs are self- refuting. As long as one admits that our beliefs are heavily shaped by the forces of natural selection, it is natural and plausible to think that objective morality could simply be an illusion.

The level of an EDA's ambition affects the argument's strength but not because more ambition causes an internal contradiction. Rather, the more set of beliefs an EDA calls into question the more difficult it becomes to provide a complete evolutionary origins story. In other words, the level of ambition of an EDA does not affect its epistemic premise, but instead it affects the strength of its empirical premise, which is the Achilles heel of any ambitious EDA.

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University of Novi Sad, Serbia

THE ANIMAL TURN, ARCHAEOZOOLOGY, aDNA: REVEALING PAST ENTANGLEMENTS

Born out of the Modernist Project, archaeology has been deeply rooted in anthropocentric ontologies ever since its beginnings. It was about humans in the past, as understood by humans in the present. And yet, through archaeological research, multiple other-than-human pasts emerge. They tell stories of coexistence, predation, extinction, commensalism, partnership, companionship, mutual becomings – i.e. the shifting webs of relations with a myriad of different creatures humans entangled themselves in. As articulated by Donna Haraway, rather than a single species, it is the assemblages of organic beings and abiotic actors which make history. In the age which came to be known as the Anthropocene, many of these webs have been impaired or broken. With the devastating rate of human-induced mass extinctions, it is estimated that the majority of species and associated ecological assemblages will be lost by the end of the 21st century. In their recent book Arts of Living on a Damaged Planet, Tsing et al. have referred to the vestiges of past lifeways and lifeforms as 'ghosts' or 'haunted landscapes'. Ultimately, the material traces of a number of non-human animals which once roamed the Earth are and will be preserved in the archaeological record only. As a discipline dedicated to the study of animal remains from archaeological sites, archaeozology provides unique opportunities to explore past entanglements of humans and non-humans, some of which have been long gone. Ancient DNA analysis offers further insights into their presence and dispersal. In this paper, I discuss a particular case study from the Mesolithic Danube Gorges, related to the discovery of Rutilus frisii, a fish species previously unknown in the region. Archaeozoological and aDNA analysis have have shown that it was once ubiquitous in the Danube at least up to the Middle Holocene. Moreover, with its perpetual, seasonal return, and specific pearl-like tubercles occurring in breeding males in spring, this species ocuppied an important place in the ontology of Mesolithic hunter-gatherer-fisher communities. The ornamental practice involving R. frisii pharyngeal teeth worn as garment appliqués suggests that human bodies could have been perceived as fluid, becoming parts of new assemblages by incorporating non-human elements. Ultimately, archaeozoological and aDNA analyses are not only vital to the reconstruction of former biodiversity, but, along with recent paradigmatic shifts to decenter the human, offer unique possibilities of thinking about multispecies pasts and histories of entanglement.

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DARWIN ON THE ORIGIN OF MIND AND LANGUAGE

There has been almost no recent work about Darwin's own writing on the origin of language and mind. Explanations of Darwin's account of the origin of human consciousness in the Descent of Man by historians and philosophers of biology, both favourable and critical of Darwin, were once common, and problems Darwin dealt with remain current in contemporary cognitive science. Though cognitive scientists like Dennett and Pinker have asserted the importance of Darwin in our account of the origin of human consciousness, these thinkers make only limited appeal to Darwin's text in this regard (Pinker, 1994; Dennett 1995).

Contemporary cognitive scientists seek to discover the origin of consciousness not only through neurobiology but through interdisciplinary appeal to such fields as psychology, anthropology, linguistics and philosophy. Such an account Charles Darwin himself gives in the Descent of Man. However, there is no consensus among cognitive scientists about how Darwin's written contribution to the question of the origin of consciousness in morphology and biology should be evaluated. Above all, there is no consensus about his reliance on the human and social science of his own day. Since cognitive science proposes to operate at the intersection of biology, specifically neurobiology, philosophy, psychology, linguistics and anthropology, Darwin's reliance on philosophers, anthropologists, psychologists and linguists who were his contemporaries should be recognized in any cognitive science account which purports to draw upon a Darwinian perspective.

Darwin's account of human and simian morphology and the brain is presented explicitly in discussion with the work of Haeckel and Huxley. Darwin's discussion of the origin of language and consciousness equally relies upon contemporary thinkers treating the relation between the origin of language and mind. Richards, like Pinker, has drawn attention to the affinity Darwin sees between comparative morphology and philology (2002). Alter has noted that Darwin's theory of the origin of language appears divided between two perspectives as it is presented in The Descent of Man (2008). Darwin, according to Alter, responds to the criticisms of Müller, who holds in the manner of Hobbes, Locke and Condillac that language and abstract thought are coextensive (cf. Taylor 2016). However, Darwin's actual, own view on the relation between mind and language is more ultimately beholden to figures like Herder, Hamann and Humboldt. Not only does Darwin deny that language and mind are equivalent to a uniquely human capacity for abstract thought; Darwin even avows that certain "higher" animals, like dogs and sheep, can engage in abstract thought, since they recognize the meaning of specific general words (1871).

Darwin recognizes a distinction between human mind and language and that of other animals. However, he affirms that mind and pre-linguistic forms of expression are features of the life of non-human animals. To recognize Darwin's insight into continuities linking as much as divisions separating human mind and expression from that of other animals would put us in a better place to understand the emergence of mind and language for the cognitive science of our current world.

4.

SELECTION EFFECTS AND EVIDENCE

KEYNOTE

Liv Nilsson Stutz
Linnaeus University, Sweden

WEAVING TOGETHER INTERDISCIPLINARY STRANDS OF EVIDENCE. A PATHWAY TO UNDERSTAND RITUAL IN THE DEEP PAST

When approaching human experience in the prehistoric past, archaeologists rely on the study of material culture and the traces of past human action. This is especially challenging when looking at aspects such as ritual, emotion, and belief. In the absence of written and oral history, we must draw on a range of different disciplines to access these elusive yet important dimensions of the past. This paper presents a case study of burials from the Mesolithic that draws on methods and theory from the natural sciences, the social sciences and the humanities. Though a combination of archaeothanatology, ritual theory, body theory and practice theory, this study exemplifies how different epistemologies can be successfully combined to bring us closer to lived experience in the deep past.

Arsham Nejad Kourki
University of Bristol, United Kingdom

BEYOND CONGRUENCE: EVIDENTIAL INTEGRATION AND INFERRING THE BEST EVOLUTIONARY SCENARIO

Molecular methods have revolutionised virtually every area of biology, and metazoan phylogenetics is no exception: molecular phylogenies, molecular clocks, comparative phylogenomics, and developmental genetics have generated a plethora of molecular data spanning numerous taxa and collectively transformed our understanding of the evolutionary history of animals, often corroborating but at times opposing results of more traditional approaches. Moreover, the diversity of methods and models within molecular phylogenetics has resulted in significant disagreement among molecular phylogenies as well as between these and earlier phylogenies. How should this broad and multifaceted problem be tackled? I argue that the answer lies in integrating evidence to infer the best evolutionary scenario. I begin with an overview of recent development in early metazoan phylogenetics, followed by a discussion of key conceptual issues in phylogenetics revolving around phylogenetic evidence, theory, methodology, and interrelations thereof. I then argue that the integration of different kinds of evidence (e.g. molecular, morphological, ecological) is necessary for arriving at the best evolutionary scenario (causal explanation) rather than merely the best-fitting cladogram (statistical explanation). Finally, I discuss the prospects of this view in stimulating interdisciplinary cross-talk in early metazoan research and beyond, and challenges that need to be overcome.

Siska De Baerdemaeker
Stockholm University, Sweden

EXPLORATORY OBSERVATIONS WITH STELLAR STREAMS

Dark matter constitutes approximately 26% of the current energy density of the universe and plays a central role in large-scale structure formation.Yet, aside from its gravitational effects, very little is known about what constitutes dark matter and the space of possibilities for dark matter candidates remains vast.Various high-energy physics experiments have been constructed with the explicit aim of detecting specific dark matter candidates. They have been complemented with ever more detailed cosmological and astrophysical observations to constrain the dark matter space of possibilities.This paper investigates the epistemological underpinnings of one recent set of observations: the use of stellar streams to map out the substructure of the Milky Way halo and thereby further constrain possible dark matter candidates (see for example Bonaca et al 2019). Stellar streams are clusters of stars orbiting a galaxy that have been torn apart and stretched out due to tidal effects. They move through the presumed dark matter halo of that galaxy, which means that they could encounter substructure in that halo. Any encounters with substructure would affect the density profile of the stream.Observations of density profiles of stellar stream in the Milky Way halo density profiles thus helps to explore the possible substructure present in the Milky Way halo, which, in turn could lead to further constraints on the space of possibilities for dark matter candidates on the one hand, and on the range of possible solutions to some of the small-scale challenges in cosmology on the other hand.In this paper, I investigate the epistemic status of such stellar stream observations. I argue that stellar stream observations fulfill a dual role. They constitute exploratory observations insofar as they are used to map out the substructure of the Milky Way halo, but they are hypothesis-driven insofar as they are used to investigate how the structure of stellar streams is affected by interaction with that substructure. In my argument, I draw on the existing literature on exploratory experiments and extend it to the current case. Exploratory experiments are commonly defined in contrast with confirmatory or hypothesis-driven experiments: they are not aimed at testing any specific local theory about the target(see e.g. Franklin 2005). Although exploratory experiments are not aimed at testing any local theory about the target, that does not mean they do not rely on such theoretical background.There is broad recognition that exploratory experiments require background theory as guidance (Franklin 2005, Karaca 2013). Building on Colaço (2018), I show that the stellar streams case reveals that sometimes observations and experiments can take on a dual role as both exploratory and hypothesis-driven, but with regards to different targets: dark matter haloes, and stellar streams, respectively. I close with an analysis of how this dual role plays out in practice

João Barbosa
University of Lisbon, Portugal

A THEMATIC APPROACH OF SELECTION EFFECTS AND BIASES IN COSMOLOGY: FRED HOYLE AND THE REJECTION OF THE BIG BANG IDEA, DESPITE THE EXPERIMENTAL OBSERVATION

After a strong dispute between the big bang cosmology and its big rival, the steady-state cosmology, some important experimental observations, such as the determination of helium abundance in the universe and the discovery of the cosmic background radiation in the 1960s, were decisive for the progressive and wide acceptance of big bang cosmology and the inevitable abandonment of steady-state cosmology. But, despite those solid experimental observations favorable to big bang cosmology, Fred Hoyle, one of the proponents of the steady-state cosmology and the main opponent of the big bang idea (which, paradoxically, himself he baptized), never gave up and continued to fight for the idea of a stationary (or quasi-stationary) universe until the end of his life, even after decades of widespread consensus around the big bang cosmology.

We can try to understand this persistent attitude of Hoyle by applying Holton's thematic analysis to cosmology. Gerald Holton recognizes in the scientific activity a dimension that, even unconscious or not assumed, is nevertheless very important in the work of scientists, in implicit articulation with the experimental and the theoretical dimensions of science. This is the thematic dimension, constituted by themata – concepts, methodologies, and hypotheses with a metaphysical, aesthetic, logical or epistemological nature, associated both to the cultural context and the individual psychology of scientists. In practice, themata can be expressed through personal preferences and choices which guide the individual and collective work of scientists.

Thematic analysis shows that big bang cosmology is mainly based on a set of themata consisting of evolution, finitude, life cycle (which has a beginning), and change; the steady-state cosmology is based on opposite themata: steady state, infinity, continuous existence, and constancy. The passionate controversy that these cosmological views carried out is part of an old cosmological opposition: the thematic opposition between an evolutionary view of the world (associated to Heraclitus) and a stationary view (associated to Parmenides). Personal preferences seem to have been important in this controversy, and Hoyle is a very illustrative example of a life-long personal commitment to some themata, in this case to the opposite themata of the big bang cosmology. His struggle against the big bang idea was strongly based on philosophical and even religious reasons – which, in a certain sense, is related to thematic preferences. In this personal and persistent struggle, Hoyle always refused the way how some experimental observations were considered decisive in favor of the big bang idea, arguing that the success of this idea is based on sociological and cultural prejudices. This Hoyle's attitude is a typical thematic attitude: the acceptance or rejection of a proof or scientific fact may be conditioned by personal themata, that is, something which is accepted by some scientists as scientific truth may be considered by another scientists, who defends different or even opposites themata, as something that is not sufficiently proven. In this case, that corresponds to the existence of selection effects and biases regarding important cosmological observations, in order to sustain a persistent rejection of the big bang idea.

Kristina Penezić
University of Novi Sad, Serbia

SCIENTIFIC FLUENCY IN MULTIDISCIPLINARY RESEARCH - EXAMPLES FROM ARCHAEOLOGY

Highly valuable in scientific research, interdisciplinarity bridges disciplines in pursuit of new knowledge. Here, multidisciplinary work on several prehistoric settlement sites in the Central Balkan region would be used as an example of the employment of different methods of investigation. As such, in the field of the reconstruction of paleoenvironment and past landscapes used by prehistoric communities, different lines of evidence are necessary. These are intertwined in the pursuit of new knowledge, new data, but also new interpretations. Cross-disciplinary approach implies fieldwork, sampling, lab processing, analysing, and interpreting the results. It involves methods, approaches, and facilities used by soil scientists, organic chemistry specialists, and archaeologists.

Integration of hard and social sciences also creates new methodological frames of multidisciplinary work, and for these to be fruitful, sometimes a new language must be employed. Learning how to communicate and create meaningful interpretations sometimes requires more than the expertise in one of the fields. Being fluent in communicating with colleagues from different disciplines, especially coming from "hard" and "social" spectrum of science is often a necessary skill required, but the one hard to master, without an available language course.

5.

ORIGINS OF LIFE IN THE COSMOLOGICAL CONTEXT

KEYNOTE

Milan Ćirković

Astronomical Observatory of Belgrade, Serbia
& University of Oxford, United Kingdom

WHO'S REALLY AFRAID OF AI? ANTHROPOCENTRIC BIAS AND POSTBIOLOGICAL EVOLUTION

The advent of artificial intelligence (AI) systems has provoked a lot of discussions in both epistemological, bioethical and risk-analytic terms, much of it rather paranoid in nature. In this contribution, I would like to suggest that at least four different classes of arguments could be brought forth against the proposition that AI – either human-level or superintelligent – represents in itself a credible existential threat to humanity in either nearby or distant future. Part of the same argumentation is applicable to the general notion of postbiological evolution, which has caused even more unnecessary confusion and uproar in both laymen and philosophical circles. While the due attention should be given to the risks and dangers of the transitional period, there are many reasons why we should openly support and cheer for humanity's transition into the postbiological epoch.

Predrag Slijepcevic
Brunel University London, United Kingdom

RECONFIGURING SETI IN THE MICROBIAL CONTEXT: PANSPERMIA AS A SOLUTION TO FERMI'S PARADOX

All SETI (Search for Extraterrestrial Intelligence) programmes that were conceived and put into practice since the 1960s have been based on anthropocentric ideas concerning the definition of intelligence on a cosmic-wide scale. Brain-based neuronal intelligence, augmented by AI, are currently thought of as being the only form of intelligence that can engage in SETI-type interactions, and this assumption is likely to be connected with the dilemma of the famous Fermi paradox. I argue that high levels of intelligence and cognition inherent in ensembles of bacteria are much more likely to be the dominant form of cosmic intelligence, and the transfer of such intelligence is enabled by the processes of panspermia. I outline the main principles of bacterial intelligence, and how this intelligence may be used by the planetary-scale bacterial system, or the bacteriosphere, through processes of biological tropism, to connect to any extra-terrestrial microbial forms, independently of human interference.

Petar Nurkić
University of Belgrade, Serbia

DARWIN MEETS DR FRANKENSTEIN: USING THE DRAKE EQUATION TO CALCULATE THE PROBABILITY OF VOLCANIC LIGHTNING'S IMPACT ON CHEMICAL EVOLUTION

Nitrogen and phosphorus are the two most important elements for the creation of Life. Nitrogen is contained in all aspects (structural-proteins, catalytic-enzymes and ribosomes, metabolic-ATP and information-DNA / RNA) of biomolecules that are important for one or more typically biological processes, such as cell division, morphogenesis or development. In order to be used for prebiotic synthesis, nitrogen must be converted to hydrocyanic acid, ammonia or nitrate during the nitrogen fixation process. In addition, phosphorus is present in ribosomes, ATP, RNA and DNA molecules. Phosphorus can be found in nature in the form of minerals - *apatite* ($Ca_5(PO_4)_3(F, Cl)$). In order to participate in prebiotic synthesis, phosphorus must be reduced to hydrophosphite or phosphite. Volcanic clouds of ash and gas represent a suitable environment for the synthesis of organic molecules and their rapid removal from the reaction zone (Markhinin & Podkletnov, 1977). Volcanic gases contain all the necessary components for the formation of prebiotic constituents. In addition, volcanic ash contains minerals of sufficient surface area and catalytic properties also required for prebiotic synthesis. Volcanic clouds of ash and gas represent an efficient source of energy due to high temperature and strong electrical discharges (Schwartz and Henderson-Sellers, 1983). In other words, for chemical evolution to be possible, a nitrogen fixation process is required to form hydrocyanic acid (HCN) and ammonia (NH_3). It is lightning that successfully produces (NH_3 and HCN (Stribling & Miller, 1987). More specifically, volcanic thunderstorms formed in volcanic clouds during high-explosive eruptions represent a significant source of reactive nitrogen and phosphorus. During these eruptive episodes, pyroclasts (rapid flows of hot gas) are formed, which further creates strong electric fields that generate lightning discharges and photochemical processes that simulate a natural chemical reactor.

Drake's equation (Dominik & Zarnecki, 2011) estimates the current number of alien species communicatively capable of searching for other intelligent species (SETI).

$$N = R_* f_p n_p f_1 f_i f_c L$$

N represents the number of civilizations that are detectable by electromagnetic emission, $\boldsymbol{R_*}$ is the formation rate of the corresponding stars, $\boldsymbol{f_p}$ is the fraction with planetary systems, $\boldsymbol{n_p}$ is the number of planets in such systems suitable for life, $\boldsymbol{f_1}$ is the fraction at which life actually develops, $\boldsymbol{f_i}$ is the fraction with the planets on which intelligent life can occur, $\boldsymbol{f_c}$ is the fraction of the planets that developed a civilization with the necessary signal detection technology and $\boldsymbol{L}$ is the time frame during which these civilizations emit such signals. Although Drake's equation was initially designed to solve this problem, due to its key characteristics, such as identifying relevant parameters in estimating the probability of a particular phenomenon and highlighting the source of uncertainty of that phenomenon, it can also be used in a wider variety of problems. For example, Drake's equation can be used to identify the time frame in which lightning was important for horizontal genetic transfer (Kotnik, 2013).

In this presentation, I will try to present another use of Drake's equation on the example of calculating the probability of the influence of volcanic lightning on chemical evolution. In addition to the general quantitative elements of Drake's equation, the essential parameters (Navaro-Gonzalez et al., 1998) would be:

- Temperature and pressure of eruptive materials T (1700°C or more) and P (between 200 and 1000 mbar)
- Soil heat dissipation rate E (340 mW m^{-2})
- Energy yield of HCN nitrogen fixation (~6x molecules J^{-1})
- Phosphite saturation in volcanic minerals C (between 1 and 10%)

In this way, we get a formula that can predict the probability of chemical evolution or prebiotic synthesis due to the influence of volcanic thunder.

6.

SELECTING BIOLOGICAL INDIVIDUALS

KEYNOTE

W. Ford Doolittle
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DARWINIZING GAIA

Darwinists have problems conceiving of communities and ecosystems as "units of selection" because most often these do not reproduce as collectives, which traditional formulations of evolution by natural selection (ENS) most often seem to require. So Lovelock's "Gaia Hypothesis" has faired poorly in traditionalist Darwinists' hands, as has the much more recent proposal that we and our microbiomes, as "holobionts", are single units of selection. Here we consider three ways to work around this – ways to legitimize, if not prove – such hypotheses. Two entail accepting that differential persistence as well as differential reproduction can give rise to or be an outcome of ENS, while the third is David Hull's replicator/ interactor framework, writ very large. (1) The first workaround is to argue that it is not the individuals or even all the taxa that make up a community or ecosystem that is the unit of selection, but the pattern of interactions (the "process") that they collectively implement – "the song, not the singers". Arguably, interaction patterns are re-produced (recur) but don't reproduce, and it's the ongoing evolutionary recruitment of taxa perpetuating such processes that defines persistent lineages. (2) The second workaround addresses clades (or analogously, clones, as in a chemostat). Although clades don't reproduce, at any given time a clade (or a clone) consists of units ('species' or cells) only some of which will have progeny in future. Thus clades always generate populations *in which* and *between* which ENS by differential persistence can act, addressing clade-level traits like species richness, ecological diversity, geographic dispersal or intra-clade cooperation. The most inclusive clade would be LUCA (the Last Universal Common Ancestor) and all it's descendants – all of Life on Earth in other words. Whether are not there are a populations of "Gaias" on other planets, there is a terrestrial population that this clade itself continuously generates. (3) Hull's framework sees recurring but non-reproducing communities as interactors whose differential success differentially perpetuates the replicators that determine their properties. The replicators might be genes, "selfish" in Dawkins' sense, but with phenotypes at the level of communities and ecosystems, of which Gaia is the most inclusive. Thinking about lateral gene transfer encourages the view that some genes are perpetuated because they are represented in many disparate species, thanks to transfer. Genes serving the global nitrogen cycle might be seen in this way. So might nitrogen fixing organisms and species, since, with respect to communities as "interactors", these too are "replicators".

Mael Montevil
Panthéon-Sorbonne University, France

HISTORICAL ORIGINS AND THE THEORETICAL DEFINITION OF OBJECTS IN BIOLOGY

In the structure of the main theories of physics, origins play a limited role. For example, the Noether theorem, the fundamental theorem to understand the connection between conservative quantities (for example, energy) and symmetries (for example, time translations), requires a starting point, but we can choose the latter arbitrarily. Symmetry breaking represents a kind of origin, the appearance of a new pattern; however, it remains limited to the choice of a pattern among predefined ones. In less technical terms, the objects described by physics (except maybe cosmology) are generic: their interactions and transformations are described by abstract mathematical structures that apply identically to classes of concrete objects. For example, the speed of light in the vacuum is the same irrespective of the origin of the observed beam of light.

In biology, the situation is strikingly different. Even though mathematical modeling often builds on the reasoning of physics, these models are limited to very limited aspects of the intended organisms. By contrast, the phylogenetic classification of living beings introduced a very original rationale. Instead of defining objects by invariants relations, it defines objects by their historical origin, their last common ancestor. This perspective provides accuracy to biological definitions, provided that biological objects generate novelties over time. This approach has limitations when we want to understand the physiology or the development of organisms and how they last over time.

Then, we argue that biology requires a perspective that integrates relational, systemic perspectives and historical definitions, i.e., definitions based on the common origin of a class of objects. Integrating these distinct epistemological stances requires significant epistemological and formal innovations. It implies that the definition of biological objects is not just about the relationship between their parts at a given time; it also requires the reference to their past.

Paul-Antoine Miquel
Université de Toulouse, France

THE ORIGIN OF BIOLOGICAL INDIVIDUATION

This short presentation will focus on the origin of life, as if its emergence could be the result of some theoretical condition, and not simply an historical-empirical fact. Following Gilbert Simondon, we will understand life as biological individuation, as if it could be the result of a recursive procedure (Miquel/Hwang, 2016; Miquel/Hwang 2021). We will summarize what such a recursive procedure could be, and what are the consequences, concerning the question of the origin of life. More particularly, we will insist on two central points: the relation between irreversibility and entropy in the new thermodynamics of physical systems out of equilibrium (Crook 1999, England 2013, 2016, 2021); the coupling between autocatalytic sets and metabolism as it could activate a thermodynamic work and constraint cycle (Kauffman 2019).

Andrej Korenić, Slobodan Perović
University of Belgrade, Serbia

ACTIVELY EXPLOITING QUANTUM EFFECTS: A VERGE BETWEEN LIFE AND (BIO)MOLECULES

Following advancements in physics and biology, the scientific community had anticipated quantum signatures generated in biological systems, posing question about their purpose on a verge between life and (bio)molecules. New possibilities opened up with fresh approaches to age-old problems in the molecular and material sciences as more advanced simulations bridge this gap. Recent demonstration of a fundamental difference between classical and quantum thermodynamics in terms of calculating physical quantities, such as entropy, could pave their way to the world of quantum tunneling that leads to genetic mutations spontaneously cropping up in a single rung of the spiraling ladder of DNA or the one of the green sulfur bacteria actively exploiting quantum effects called vibronic mixing to steer the excessive energy where it can be quenched. For the first time a research team has shown that water and organic matter can evolve in situ on the surface of Itokawa, and likely many other asteroids in our solar system, as well as being delivered there via meteorite and space dust impacts, over aeons of celestial time. In addition, even the iconic genetic code can now be viewed as an “energy code” that evolved into a nearly uniform blueprint across all living species through self-replicating DNARNA mixes knitted together by a simple compound called diamidophosphate. Furthermore, although we still observe many gaps in the evolution of life, we see from recent studies, for example, that most of the Ediacaran animals still possessed some basic features that persist today including left-right symmetry, apoptosis, immune system, body segmentation, noncentralized nervous systems, musculature and master controllers known as high-level regulatory genes. On one hand, increasing number of evidence now support appearance of similar evolutionary patterns independently several times during evolution. On the other hand, discovery of some novel exaptations, like developing of the first bones to serve as mineral deposits or development of the neuromuscular system and pathways that controlled ancient vertebrates’ scuttle along the sea floor, change the evolutionary timeline as we knew before. All these seemingly unrelated phenomena could be the result of life actively exploiting the process of symmetry breaking, used as a conceptual tool in physics to identify subatomic particles and their properties for many decades. Based on this theoretical framework, one could identify the basic structure of symmetry breaking across biological scales, namely emergence, propagation, and cascading of symmetry breaking-induced layers across the biosphere.

Franziska Reinhard
University of Vienna, Austria

THE ROLE OF CONSTRAINTS IN ORIGINS-OF-LIFE RESEARCH

Contemporary research into the origins of life is a highly interdisciplinary endeavour seeking to account for how our biomolecules formed from simple precursors and self-assembled for the first time on the early Earth, more than 3.5 billion years ago. Even though the research target is historical, unlike other historical sciences, origins-of-life research is largely experimental – famously starting with the Miller-Urey experiment in 1953. This is due to a challenging epistemic situation: direct evidence for chemical processes on the early Earth is extremely scarce, and prebiotic conditions are uncertain. However, experimental research also needs to start somewhere, even if the target is a long-completed historical process. As Winsberg (2009) remarks: "In both cases of simulation and experiment, you need to know something to learn something." This seems to pose a special problem for sciences of the origin, including origins-of-life research. How do scientists gain traction in this kind of epistemic situation?

In this talk, I argue for the importance of constraint-based research strategies as a way of dealing with the above issue in origins-of-life research and historical sciences more generally. Constraints limit and therefore reduce the number of factors or values we need to take into account when investigating a specific scientific target – they tell us something about a target and guide further investigation by excluding things. A detailed account of the role of constraint-based reasoning and explanation in the life sciences has been given by Green and Jones (2016). They focus on the role of formal constraints in systems biology, but their account allows for other kinds of constraints as well and I am going to use a generalised version of constraint-based reasoning to apply to specific cases from origins-of-life research.

I focus on two examples from origins-of-life research to illustrate the importance of constraints. Both fall under the subfield of prebiotic chemistry. Prebiotic chemists study the formation of biomolecules under prebiotic condition drawing on methods from synthetic organic chemistry. The first example shows the importance of combining constraints from different disciplines to ensure that prebiotic chemistry experiments employ reaction conditions that are 'prebiotically plausible'. The second example consists of a sequence of experiments that synthesize potentially prebiotic nucleic acids in the structural neighbourhood of RNA. I argue that while in the first example, the researchers apply constraint-based search and reasoning, the second case goes beyond that: the emphasis is on experimentally determining usable constraints in the first place.

Finally, I compare the role of constraints and constraint-based reasoning in origins-of-life research to existing accounts of reasoning in historical sciences, particularly those focusing on consilience (Forber & Griffith 2011, Wylie 2011) and coherence (Currie 2017). I take my points to be largely compatible with these accounts.

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SELECTION EFFECTS IN GAIA AND SOLARIS

The progress in astrobiology has revealed a great number of planets partially physically similar to Earth in the Galaxy. Most of them are much older than our planet, so a naïve application of the Copernican Principle would suggest that most of them inhabit biospheres similar to the Terran ones. There are multiple problems with such an application, and a research program aiming to assess and quantify the degree of specialty or mediocrity of our biosphere and its evolution has to face several pivotal observation selection effects. Specifically, it is crucial to try to analyze different ways in which biospheric evolution could have diverged from the Terran template elsewhere. In a paper currently in progress, we propose an alternative macroevolutionary pathway that may result in the tight functional integration of all sub-planetary ecosystems, eventually giving rise to a true superorganism at the biospheric level. The blueprint for a possible outcome of this scenario has been masterfully provided by Stanisław Lem in his 1961 novel Solaris. The Solaris scenario offers such a persuasive and powerful case for an "extremely strong" Gaia hypothesis, that it is, arguably, high time to investigate it in the discursive astrobiological and philosophical context. We briefly outline the argument by which most biospheres in the Galaxy have intrinsic radically different coding concepts and significantly less chance to be found by astrobiological searches calibrated on the Earth's version of Gaia.

7.

BIBLIOGRAPHY

How Computation Explains

Chalmers, D. J. (2011). A Computational Foundation for the Study of Cognition. *Journal of Cognitive Science*, 12, 323–357.

Edsel, A. (2016). *Breaking Failure*. New Jersey: FT Press.

Miller, M. (2014). Minds Online: Teaching Effectively with Technology. Cambridge MA: Harvard University Press.

Peacocke, C. (1994). *Content, Computation and Externalism*. Mind & Language, 9(3), 303–335.

Piccinini, G. (2015). *Physical Computation: A Mechanistic Account*. Oxford University Press.

Biases and Selection Effects in Relation to Cosmological Fine-Tuning

Bradley, D. J. (2009) 'Multiple universes and observation selection effects,' *American Philosophical Quarterly*, 46: 61–72.

Collins, R. (2009) 'The teleological argument: an exploration of the fine-tuning of the cosmos,' in W. L. Craig and J.P. Moreland (eds.) *The Blackwell Companion to Natural Theology*, Oxford: Blackwell, pp. 202–281

Lewis, G. J. & L. A. Barnes (2016) *A Fortunate Universe: Life in a Finely Tuned Cosmos*, Cambridge: Cambridge University Press.

Sober, E. (2003) 'The design argument,' in Manson, Neil A. (Ed.) (2003) *God and Design: The Teleological Argument and Modern Science*, London: Routledge, 27-54.

Introducing the subject into Big History: a mask of theory over the face of nature

Christian, D. (2018). *Origin story: A big history of everything*. Hachette UK.

Misak, C. J. (2014). "Language and experience for pragmatism." *European Journal of Pragmatism and American Philosophy* [Online], URL: http://journals.openedition.org/ejpap/295; DOI : 10.4000/ejpap.295.

Whewell, W. (1847). *The philosophy of the inductive sciences, founded upon their history,* 2nd edition, 2 vols. London: John W. Parker.

Exploratory observations with stellar streams

Bonaca, A. et al. (2019) "The Spur and the Gap in GD-1: Dynamical Evidence for a Dark Substructure in the Milky Way Halo", *Astrophysical Journal,* 880(1): 12 pp.doi: 10.3847/1538-4357/ab2873

Colaço, D. (2018). "Rethinking the Role of Theory in Exploratory Experimentation." *Biology and Philosophy* 33 (5): 1–17.

Franklin, L. R. (2005). "Exploratory Experimentation." *Philosophy of Science*, 72 (5): 888–99.

Karaca, K.(2013). "The Strong and Weak Senses of Theory-Ladenness of Experimentation: Theory-Driven versus Exploratory Experiments in the History of High-Energy Particle Physics". *Science in Context* 26 (1): 93-136.

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