A New Era of Complexity for the 21st Century – the Interactionist Turn

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Echoing and updating the thoughts of Sir Julian Huxley about humans directing evolution, Laurence exposes an inconsistency in the modern scientistic view that the universe is causally closed. Instead he shows how mind and culture now shape nature. Laurence will be speaking at the Annual Gathering in July.

The story begins shortly before the middle of the seventeenth century and after the publication of Descartes's widely influential scientific writings. By then, according to science historian Thomas Kuhn, most physical scientists came to assume that ours was a corpuscular universe, one in which "all natural phenomena could be explained in terms of corpuscular shape, size, motion, and interaction" (41). Over the next three-and-a-half centuries the concept of *corpuscle* would undergo considerable sophistication and precision. But the template was set: the corpuscular conception of the universe told scientists what sorts of questions to ask and what many of their research problems should be. For Kuhn, this nexus of commitments "proved to be both metaphysical and methodological":

> As metaphysical, it told scientists what sort of entities the universe did and did not contain: there was only shaped matter in motion. As methodological it told them what ultimate laws and fundamental explanations must be like: laws must specify corpuscular motion and interaction, and explanation must reduce any natural phenomenon to corpuscular action under these laws.

This nexus of commitments underlies today's prevailing scientific philosophy. Call it the principle of the closedness of the physical domain. Theologian-philosopher Phillip Clayton describes this philosophy:

> Reality consists of fundamental material particles; these basic particles, together with the forces that act upon them, determine the behaviour of all objects in the world; all else is built up out of these constituents…all causal arrows point upward from the fundamental microphysical causes, and all explanatory arrows point downward (51).

Against this backdrop, Oxford physicist Roger Penrose observes:

> Science seems to have driven us to accept that we are all merely small bits of a world governed in full detail (even if perhaps ultimately just probabilistically) by very precise mathematical laws. Our brains themselves which seem to control all our actions are also ruled by these same precise laws.… (1998).

Here the poet gets it right:

> Who is ridden with a conscience
> Worries about a lot of nonscience.
>
> Ogden Nash

Echoing a consensus of fellow Nobelist scientists when they exchange their lab coat for their philosophical hat, physicist Steven Weinberg speaks of "the discovery, going back to the work of Newton, that nature is strictly governed by impersonal mathematical laws" (12). Physicist Murray Gell-Mann makes this point more casually: "Life can perfectly well emerge from the laws of physics plus accidents, and mind from neurobiology. It is not necessary to assume additional mechanisms or hidden causes" (1126).

The logic of this scientific philosophy is that by allowing for the possibility that some causal arrows point downward or some explanatory arrows point upward we compromise science's ontologically reductionist programme. This would open the door to the possibility that mindful intelligences like us could subvert the direction of these arrows, thus undermining the legitimacy of the claim for the universality of the "laws of nature." Suppose we were permitted to say that such intelligences can sometimes freely choose to go to the fountain to get a drink of water. There exist no mathematical equations that explain such a trip. Today's neurobiology doesn't explain it; it describes some of the operative neurophysiological mechanisms by which it might occur. Yet to permit such a proposition would be to subvert the methodology that has underwritten modern science from the start. Permitting purposeful behaviour would violate the worldview of this science. Cognitive scientist Steven Pinker expresses this worldview when he says "the facts of science [expose] the absence of purpose in the laws governing the universe" (31). We have only to look at the successes of today's particle physics and astrophysics and their commitment to the universality of their natural laws to assess the cost of denying such a proposition. It seems a small price to pay for these astonishing successes.

To get a fuller understanding of this price, consider for a moment an alternative scenario that calls for "additional mechanisms or hidden causes," one not compatible with the idea that we are "governed…by very precise mathematical laws." Within the last half-century we have learned to engineer and reengineer our own "naturally" selected genetic code and that of other species as well. Step by step we have begun a makeover of ourselves and our terrestrial environment. Lately this has come to include our extraterrestrial environment. Theoretical biologist Stuart Kauffman tells this story: "Americans, fearful of Sputnik, landed men and mass on the moon. Parting, they left mass, changing the orbital dynamics of the solar system and beyond" (120). Each successive step poses a further threat to the reign of the principle of the closedness of the physical domain. Given such a scenario we could speak of today's physics as the study not of universal, timeless laws but of current *tendencies* of nature. It is not surprising that for the scientiser all intelligibility must come down (be "reduced") to scientific intelligibility.

This identification of scientific intelligibility with the principle of the closedness of the physical domain whereby the activities of people (culture) are immaterial to the evolutionary dynamics of the universe (nature) defines culture-nature dualism. This dualism can be encapsulated as follows: if nature can impact culture, the relation is not symmetric; culture cannot causally impact nature. Recognition of this quasi-metaphysical network of commitments, call it a meta-narrative, is significant only so far as it is accompanied by the credible possibility of a counter meta-narrative, culture nature interactionism: increasingly the natural world is a joint product of cultural and natural forces; not only are we observers of nature, more and more we become agents of its change. This is an historical observation.

Throughout the prior history of Western civilisation this alternative has been impractical and untested. From the beginning our civilisation has been understandably rooted in culture-nature dualism. From the earliest days of finding ourselves on the planet we had little choice but to erect protective shelters for withstanding the powerful forces of nature. How could we have contemplated a world in which our small clan, tribe, village (culture) might wrest some control from these forces? We had to invent titans, Prometheus, who would, on our behalf, steal fire from the gods thereby sending us on our independent course. Clearly the universe was governed by sovereign laws (or gods) beyond our dominion. When philosophy took hold in the first millennium BCE, this was the received story. And it has remained essentially intact over the ensuing two millennia.

Plato memorably crystallised this story in his myth of the cave: humans huddling in the cave (culture) watching the flickering shadows on the wall enacting the events of the outside world (nature). In one form or other this myth reenacted the common assumption of Western dualist thinking for the next two millennia: nature spoke, culture listened. In this context Whitehead's often repeated comment that the philosophy of the past two thousand years can be understood as "footnotes to Plato" gains credibility. The myth infuses our Western concepts both of art and science as well as our sense of what it is to be human. That this has been our standard background myth becomes clearer when contrasting it with culture-nature interactionism.

According to this alternative myth, now wielding a "blue guitar," coming of age in the Milky Way cave dwellers rise, turn, and depart the cave for the vast spaces outside. Interacting with these spaces they learn to navigate their way about them to their purposes, "[re-] making the sea whose song they sing." In the course of defending themselves against the remorseless forces of nature, through the combination of intelligence and an opposable thumb an unexpected event transpires. They evolve ways of leveraging these forces to their ends. Here is the basis for a successor meta-narrative. Our stone tools morph into earth refashioning instruments like steam engines, nuclear reactors, and gene-splicing methodologies enabling us to subdue nature locally. Moreover, there seem no logical limits to what counts as "local."

In the dualist meta-narrative, humans are finally extraneous to the unfolding of the universe. If they can come to understand the laws governing its dynamics, they have no role in the playing out of these dynamics. For all nature cares, they are "momentary cosmic accidents" (Gould, 8), "a chemical scum on a moderate sized planet, orbiting around a very average star in the outer suburb of one among a hundred billion galaxies" is the way physicist Stephen Hawking depicts us (1988). (Contrary to some claims made for it, quantum mechanics doesn't change this story. If the experiment/experimenter alters the subsequent quantum evolution of the system, it/he has no sustained intentional control over the direction this evolution takes.) By contrast, in the interactionist meta-narrative mindful intelligences like ourselves are understood not only as interested observers but as active collaborators of natural change.

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From an interactionist perspective a dualist philosophy of science is seen to be historically shortsighted. Consider the previous claim that not only are we observers of the natural world but agents of its change. In his book on the rise of complexity in nature cosmologist Eric Chaisson quotes "some long-forgotten wit": "Hydrogen is a light, odorless gas which, given enough time, changes into people" (2001, 2). These changes comprise the history of cosmic evolution, "the sum total of all the many varied changes in the assembly and composition of radiation, matter, and life throughout the history of the Universe." They are changes "that produced our Galaxy, our sun, our Earth, and ourselves." These "ourselves" make up those of us who, over the past four hundred years, by virtue of first studying these changes scientifically, then technologically applying this knowledge to our ends, have begun causally to impact our Galaxy, Sun, Earth and ourselves. Through the agency of today's cultured and technological civilisation we are creating "hybrids" of ourselves and of other species. By means of recombinatory genomics we have learned to bioengineer our genome. We can move individual genes from one organism into another, as when we transplant a gene from an arctic flounder into tomatoes to create frost-resistant tomatoes. We are learning to concoct lab genes from scratch, stitch them into a set of genetic instructions, and implant the new code into an organism making cells that can hatch new things. Things nature hasn't seen before. Thus do we leapfrog the "naturally" selected lineage about which Darwin taught us. The resulting genotypes are what Darwin, when speaking parenthetically of the plant and animal breeders he admired, called "methodically" selected hybrids of that lineage. Our creations. "The key is man's power of accumulative selection: nature gives successive variations, man adds them up in ways useful to him" (1964, 50). He generates hybrid worlds.

At another level, as a result of our human presence and the collective choices we make, we are materially altering the chemical composition of the Earth's lithosphere, hydrosphere, and atmosphere. Already we have punctured the ozone layer. Beyond this border, we have walked on the moon so altering its physical contours. Through our rover landings we are seeking to terra-farm Mars, precipitating a possible second, interplanetary agricultural revolution. Explorer 1 recently entered interstellar space. Measured cosmologically, in a very short period of time ours has become an ever-expanding footprint. Nor does there seem to be a logical limit to the reach of this footprint. Just as significant, the changes cited are irreversible. The persistence of their effects doesn't depend on the continued existence of our species. Part of nature's evolutionary dynamics, once initiated, these effects reverberate indefinitely throughout the cosmos. Already we are agents of cosmic change, embedded in nature's fabric.

This is a different scenario than that with which we grew up. It bespeaks a change in the way evolution evolves- -from unconscious and "natural" to conscious and "methodical." "The dawn of the second great transformation in all of history," Chaisson calls it (2005, 436). After the brief, primordial era when radiation prevailed, for the next ten billion years matter dominated all physical changes in the universe. The matter era, it was one in which all causal outcomes can be attributed to a series of connected events each of which pertains to a physical modality. Thus the flow of heat from the center of interstellar clouds produces the energy needed for forming stars: heat flow, energy, stars. With the advent of the life era three billion years ago, the same strategy obtained for biophysical events. Thus the natural selection of a population's life-forms with advantageous traits adapt to a changing environment and pass on to their descendants these traits: advantageous traits, adaptation to a new environment, new traits. Each pertains to a biophysical modality. Our scientific methodology is eminently suited for explaining such events: in each of them causal arrows point upward and explanatory arrows downward. The causal closedness of the (bio) physical domain remains intact: ontological reductionism. To the extent that these events persist throughout the present era, this methodology retains its efficacy today.

Within our lifetime, alongside these eras another era has come into visibility, one signaled by events like those identified in the first two paragraphs of this section. These events remind us that we live also amidst the emergence of a fourth era. Call it the mind, or culture, era.

It is symbolised by the earlier story about a change in the orbital dynamics of the solar system. The story is a parable for the emergence of the new era. According to it, this change in orbital dynamics resulted from a geopolitical decision. Following a successful Soviet spaceflight, American officials: "fearful of Sputnik"- -initiated a programme to land a man on the moon. A decade later they brought the programme to fruition. So doing they changed the orbital dynamics of the solar system and beyond: a cultural decision served as a causal agent in altering a natural process. In the lexicon of our received physics this represents a category error: culture, in this case, a self-conscious geopolitical decision, is not supposed to causally interact with nature. Causal arrows are pointing the wrong way.

From proceeding unconsciously and "naturally," evolution now evidently proceeds also consciously or purposefully. The quotation marks signal the fact that with this quite extraordinary, still unexplained, emergence of mind, or self-aware consciousness, in the universe the nature of evolution itself changes. Chaisson calls this "a transformation of astronomical significance…an event in spacetime when technological life-forms begin manipulating matter more than matter influences life, much as matter eventually came to dominate radiation earlier in the Universe" (2005, 436). As the above parable is meant to suggest, this transformation weaves aesthetic and technological intelligences like ourselves into the fabric of universal evolution. We are bred into the universe. By degrees, through such intelligences, the universe becomes conscious of itself. Such is the significance of shifting from a dualist to an interactionist meta-narrative. One is predicated on the idea of a nature that exists independently of culture or people, the other is not. Referencing an observation by physicist David Deutsch, philosopher Barry Dainton wonders aloud whether our familiar construal of the Copernican revolution is misguided: "It may well be that there is nothing more significant than us in the entire universe" (28).

By contrast, physicist Alan Guth says "Reality exists independently of people. The goal of physics is to understand that reality" (277). But if we are to accept the adage that to be real is to have causal power, the reality that today's physics tracks is but a partial reality, and the goal it sets for itself, to understand all reality, is short-circuited.

3

It may be that we should view the scientific philosophy of Gell-Mann and his peers as better suited for explaining the evolutionary dynamics of the universe with which we intellectually grew up and which shapes the unspoken philosophy of our physics textbooks. Here the focus is on events like those investigated today by particle accelerators and astrophysical viewing technologies. These events are continuous with events that preceded the emergence of technically competent intelligences like ourselves who conceivably can now begin to exercise some long-term influence on these events. What Gell-Mann knows is that the general methodological strategy of linking all physical phenomena into a common explanatory algorithm requiring fewer and fewer assumptions has served the test of time. He knows too that no other algorithm yielding comparable explanations of these phenomena has been tested and confirmed to the same degree or pursued over a comparable period of time. And should a rival candidate be proposed, he realises that more than likely it would involve some form of nonreductionism or teleology. Since our modern science, so very successful at explaining so much that hitherto had gone unexplained, was designed in part to eliminate the need for non-reductionist or teleological explanations, its reintroduction, says Gell-Mann, "seems to me so ridiculous as to merit no further discussion" (1995). So for sound meta-scientific reasons we are well advised to stay the course, the atomistic (or quantum) course.

Taking the interactionist turn affords a more robust vocabulary, one that can entertain alternative meta-narratives. Cosmologist Brian Swimme speaks of a graduated historical shift from an unconscious, one-dimensional to a conscious, bidimensional universe:

> Stars evolved for billions of years with no human consciousness involved. And yet now these same fusion processes are understood and activated by human consciousness and expertise. Genetic mutations proceeded for four billion years outside of human consciousness. But now alterations in the gene are being carried out within the human project. For billions of years natural selection organised the evolutionary processes of Earth. But now this unconscious natural selection is being supplemented by a conscious selection: a vast number of species now evolve under pressures by conscious human decisions. (101)

These historical developments illustrate how evolutionary dynamics can themselves evolve. They can evolve seamlessly from unconscious material (atomic) and biological (genetic) to conscious technological (memetic) processes. "Stated simply, where for thirteen billion years evolutionary dynamics proceeded in a largely unconscious manner, now with the human, *these* same dynamics are unfolding within conscious self-awareness…." Knowledge, like that presently possessed by humans, occupies the space created by the universe for viewing its self-portrait, the space for consciously carrying out its future project: tomorrow's cosmogenesis. This transformation shifts the agency of universal change from unconscious physical phenomena, like fusion processes occurring within the sun, to include also conscious meta-physical phenomena like social decisions that can mindfully activate (or deactivate) these latter processes to suit ongoing cultural purposes.

Introducing teleological causality makes the universe bipolar, that is, culture-nature interactionist. On this view, mind - - or knowledge - - though a late arrival, is seen to be as fundamental to cosmic evolution as matter and energy. It actively "converses" with matter and energy. Through this capacity to move matter and energy it has the potential to alter the course of evolution. The dynamic of cosmogenesis shifts from the unconscious movement of masses and electric charges to include conscious decisions as to how to steer this movement. In order to account for this directive role of mind, our vocabulary needs a configuration space sufficiently inclusive to permit culture-nature conversation, a steerer and a steered. A thought experiment by Deutsch maps this space (1997). He asks us to imagine a future civilisation on Earth with the knowledge to modify the dynamics of the solar system on a grand scale. Physicist Paul Davies encapsulates his experiment. "Perhaps this civilisation wishes to use its knowledge of astrophysics to prolong the lifetime of the sun by altering its composition in some way.

> Now the evolution of the stars like the sun is already well understood and the properties of an aging sun can be determined rather precisely by the application of the standard laws of nuclear and plasma physics. An alien observer on the far side of the galaxy who modeled the behavior of our sun in this manner would fail to find agreement with observations because the sun would have been altered by the scientific knowledge of the terrestrial civilisation. In this case knowledge has an impact big enough to rival the standard processes in astrophysics such as the flow of heat from a stellar core (207).

One implication is that our current astrophysical laws are not, after all, entirely predictive. Nor are they universal. They omit a significant agency of change, mindfulness, an agency not readily responsive to a set of mathematical equations. At the moment this scale of cosmic engineering is still the stuff of science fiction. Yet on its face it is just an extension of the way we have already modified the terrestrial and extraterrestrial environments, modifications that just a century ago would themselves have been the stuff of science fiction. There is no reason Davies concludes, "that life and mind cannot, over eons, transform the structure of the universe on a very large scale…." The particular terminology- -"mindfulness," "purposefulness," "teleological," "intentionality, "singularity"- -is not important. Important is whether our science has a vocabulary rich enough to speak of phenomena like that projected by such a thought experiment.

In this regard consider the *New World Dictionary* description of physics: "the science of dealing with the properties, changes, interactions, etc. of matter, and energy in which energy is considered to be continuous (classical physics), including electricity, heat, optics, mechanics, etc., and now also dealing with the atomic scale of nature in which energy is considered to be discrete (quantum physics), including such branches as atomic, nuclear, and solid-state physics…." According to what has been said so far, a future edition will need to add to atomic, nuclear, and solid-state physics what we may call interactive-state physics. This addition responds to the relatively recent "second great transformation in all of history." It is the transformation that occurs when a cultured and technological civilisation like ours interacts with matter and radiation to measurably alter them to its purposes, making causal arrows point downward and explanatory arrows upward. If we are fully to understand the dynamics of the universe we inhabit, it would appear that we need to account not only for what matter and energy produce together, the burden of the physics as outlined in the dictionary definition. We would need to account also for the newfound ability of conscious change agents like ourselves to steer the matter and energy of whose activities our traditional physics informs us.

Interactive-state physics thus serves to amplify the vocabulary of physics by an order of magnitude. Mindful causal agency, like that exercised by aesthetic and technically competent beings, no longer is simply a philosophical concept, like free will. If to be real is to have causal power, such an agency is a scientific concept for the same reason that matter and energy are scientific concepts: by moving matter and energy it can change nature. In this way it meets the minimum requirements for being a scientific concept. Deutsch describes the sequence of these requirements. First we postulate "a new theory to explain some class of phenomena and then [we perform] a *crucial experimental test*, an experiment for which the old theory predicts one observable outcome and the new theory another. One then rejects the theory whose predictions turn out to be false" (6-7). A physics that overlooks this agency is a physics whose explanatory reach is shortcircuited in ways suggested by the passage quoted from Swimme. In retrospect, today's modern physics now is seen as logically equivalent to an indispensable formal subset of a more comprehensive physics that explains all that it predecessor explains plus at least some of what it does not. Here is a new story of complexity for the 21st century.

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