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No Outside: A Continuum Model of the Cosmos

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Abstract

Over the last sixty years computational modeling of dynamical systems has increasingly come to rival theory and experiment as a legitimate contributor to the ever growing body of scientific knowledge. In particular, the ability to model systems' future and past states—to speed up or slowdown their inter/intra-relationships—has revealed once hidden spatial and temporal patterns that complicate taxonomic conventions, e.g., those separating living from non-living levels of organization. The fixed position of the viewing subject is, itself, destabilized in this modeling process as temporal frames become relativized. What follows are some thoughts on what it might mean were the human to be willing to untether itself from its imagined privileged position within a spatiotemporal hierarchy and explore instead the proposition of an open-ended spatiotemporal continuum.

Keywords: *Topology; Fractal; Computation; Scale; Morphology*

Over the last 50 years, computational modeling of dynamical systems has increasingly come to rival theory and experiment as a legitimate contributor to the ever-growing body of scientific knowledge. Being able to visualize ever more informationally dense, complex systems, be they physical, biological, social, etc., through quantification of their (sometimes hypothetical) elements has revealed patterns and relationships within and between these systems that have defied discovery by more traditional methods. This has led, for example, to the discovery that many self-organizing systems follow similar patterns of growth, distribution, and proportion. In only the last 20 years, biologists have discovered that, "[w]hen adjusted for size and temperature, all organisms [ranging over 27 orders of magnitude from mitochondria to blue whales], to a good approximation, run by the same universal clock with similar metabolic, growth, and even evolutionary rates" (West & Brown, 2004, 40). Coupling this finding with that of other researchers, such as Nobel Prize-winning chemist Ilya Prigogine, who documented nontrivial, morphological commonalities between living and nonliving systems, and one begins to wonder if the human hasn't sacrificed its striving for a better understanding of its place in the universe on the Procrustean bed of its own solipsistic anthropocentrism. What follows are some thoughts on what it might mean were the human to be willing to untether itself from its imagined privileged position within a spatiotemporal hierarchy and explore instead the proposition of an open-ended spatiotemporal continuum.

This image (Figure 1) is an illustration (Briggs, 1992, 139) of the Vague Attractor of Kolmogorov (VAK), a 3D phase portrait of the "peculiarly empty orbits" that are found in an otherwise crowded belt of asteroids located between Jupiter and Mars. Long a mystery,

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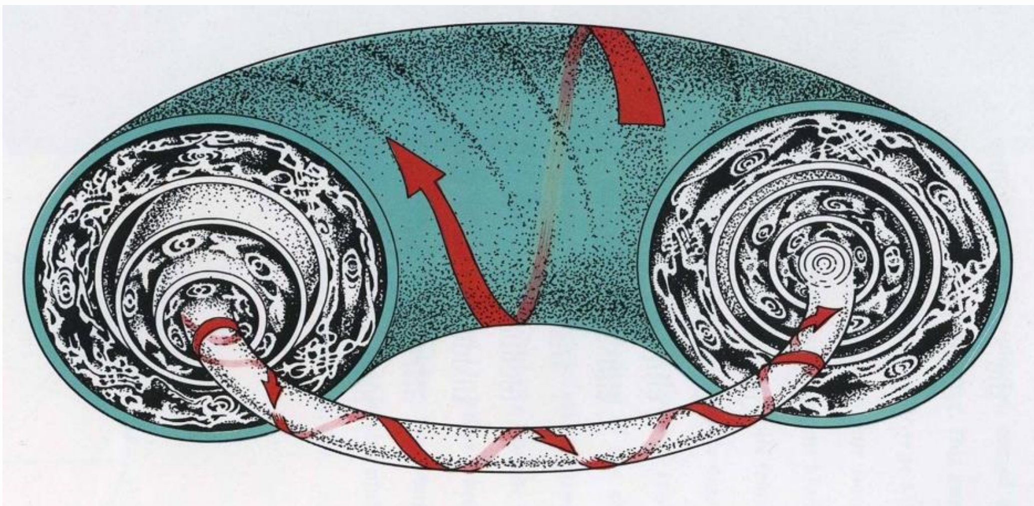
Soviet mathematician Andrei Kolmogorov showed that these unoccupied bands of space are the result of the friction and resonance set up by the combined effects of the motions of Jupiter, the Sun, and Mars.

Figure 1. The illustration of the Vague Attractor of Kolmogorov (VAK)



The resulting interference patterns entrap asteroids within the phase space of a torus-shaped strange attractor, turning them end over end along an interpenetrating spiral path (as indicated by the red arrows in the illustration). Encountering the attractor's alternating rings of turbulence and calm, a captured asteroid corkscrews wildly until the amplification of its oscillations causes its ejection from the system altogether, leaving behind the discontinuity which had originally drawn Kolmogorov's attention. This combination of order (in the overall shape of the asteroids' phase portrait) and chaos (in the vagaries of their specific movements) is characteristic of strange (or vague) attractors. In complex systems such as commodity markets and weather patterns, where one element affects every other, only the system's gross features can be predetermined while the specific details of its internal dynamics remain inherently unpredictable. The VAK image (what one might think of as a cross-section of a simplified Mandelbrot set) provides us with an intuitively graspable example of how simulation technologies are making legible, and acting to subvert, dualisms such as chaos and order. At the same time, the fractal, scale-invariant nature of its involuting folds reveals its potential to act as a stripped-down, formal model for similar dynamical systems found throughout the scalar holarchy.

Only with the advent of computers and numerical modeling in the '60s were scientists able to tackle the sort of three-body problem that is represented by the Vague Attractor of Kolmogorov. Up until this point, the fact that the vast majority of real world, physical interactions were nonlinear (and thus impervious to the traditional Newtonian or probabilistic methods of analysis) had been largely ignored by scientists. While their disinterest was due in part to the virtual insolvability of nonlinear differential equations, it also reflects the difficulty researchers face in trying to step out of a reality which has been shaped by the rational epistemologies and analytical tools typically used in its investigation. These tools and habits of thought served to render a world which was dualistic, deterministic and, due to the inherently subjective and thus unmeasurable nature of qualitative assessments, "value-free".

However, even as investigators' tools and modes of thinking evolved in lockstep with their attempts to impose order on (what was imagined to be) nature's few remaining outposts of chaos (e.g., turbulence, circuit noise, laser instabilities), the former began to undermine, counter to their originators' intentions, the foundations of the very knowledge systems they had been developed to support and expand. Chaos theory, complexity theory, and dynamical systems theory were all derived from the original impetus towards foundationalism, and it was they (in conjunction with their counterparts in the humanities, i.e., poststructuralism and postmodernism, as well as those investigating second order cybernetics) that collectively began to reveal the limitations of those non-reflexive constructions of reality which dominated the modern era. As sociologist Anthony Giddens points out, this was not solely limited to epistemological concerns but took on real-world significance as well:

> No matter how well a system is designed and no matter how efficient its operators, the consequences of its introduction and functioning…cannot be wholly predicted…New knowledge (concepts, theories, findings) does not simply render the social world more transparent, but alters its nature, spinning off in novel directions (Giddens, 1990, 153-154).

While Giddens is speaking here of social systems, the same can be said of their physical and organizational counterparts (e.g., road, computer, energy, and information networks) as these, too, are examples of the scaffoldings humans erect to support the extension of the species within a four-dimensional reality. These same scaffoldings then act to shape future growth in ways both unpredictable and of sometimes questionable benefit to those who erect them.

Even though both Gödel and Bohr had, by the 1940s, already done much to destabilize the classical scientific worldview, the visual evidence supplied by researchers like Lorenz, Smale, Wolfram, and Mandelbrot made the development of a new epistemological perspective that much more urgent. From the mid-70s onward, there was a growing emphasis among physicists, systems scientists, and philosophers of science on trying to understand the significance and behaviors of organized complexity. Sensitivity to initial conditions, or the so-called "butterfly effect", demonstrated graphically the limits of reductionism at the level of "real-world" interactions, much as Bohr's concept of indeterminacy had done at the quantum level. Advancements in digital computing revealed that complexity could be reduced to simple laws only in a minority of cases, while also allowing scientists to focus on the internal dynamics of a system, or on its "becoming" rather than strictly on its "being". Such advancements as semiconductors and parallel computing uncovered a world shot through with self-similarity, scale-invariance, circular causality and "orderly disorder", the very kinds of phenomena which are now believed to define inter- and intra-system relationships, but which had remained largely undiscovered by technologies capable of capturing only the gross, homeostatic features of a system. Resonances, attractors, scaling phenomena, and solitons (i.e., standing waves), some of science's more recent objects of study, all reveal a focus on the dynamic interactions which enhanced computational technologies are now beginning to allow researchers to iteratively model.

Niklas Luhmann, Katherine Hayles, and Andy Clark all acknowledge the revolutionary nature of these developments and their implications for a possible transdisciplinary approach within the humanities and the sciences to problems of description, observation, and interpretation. That such an approach has not been successfully implemented before is testament to the difficulty of finding a framework that is able to accommodate the socially and historically contingent construction of all knowledge while avoiding the potential pitfall of "anything goes" relativism. The systems sciences may have provided this framework by graphically demonstrating the mutual constitutivity of the dualisms at the heart of these debates (e.g., chaos/order, presence/absence, local/global), allowing for a much-needed rapprochement between the sciences and the humanities.

Undoubtedly, the most prominent feature of the Kolmogorov attractor is its constitutive void, which distinguishes the phase space of the system topologically as a torus rather than a sphere. Comparing this formal model to the central feature of social theorist Luhmann's version of systems theory, we find a homeomorphic, centralized void around which a given self-reflexive, living system (of whatever scale?) forms. The oscillations (e.g., between unity/duality, presence/absence, inner/outer) that allow the system to maintain itself as such are paradoxically grounded in this unifying aporia, which must remain forever invisible to the system itself, or in Luhmann's (1990, 76) terms, "…the operation [of distinction on the part of a system] emerges simultaneously with the world which as a result remains cognitively unapproachable to the operation. Reality is what one does not perceive when one perceives it". Only through the observations of other systems, then can a system learn about what it cannot detect within itself, making the constitutive blind spot not the source of alienation from the world as one might expect, but rather that which makes possible a system's ability to perceive and cognize *at all*. This understanding of the limits inherent in transcendental observation and the paradoxical possibilities it creates for sociality has broad implications for how we understand the future possibilities of the human.

In examining the relationship between Hayles' work on embodiment issues and our illustration of the Vague Attractor of Kolmogorov, we discover an inversion of the equation she makes between posthumanism and its tendencies towards discourses of disembodiment. In this instance, we are presented with a presence (the asteroid belt) which reveals an absence (the VAK) which discloses a presence (resonant forces) which becomes "embodied" as an object of study through the art of iterative computational processes. Revealed to the viewer in this cross-section of the interpenetrating spiral is the complementarity between the system's simplicity, as seen in its recursively symmetric, fractal organization, and its complexity, as demonstrated by the disruptive pockets of fine-grained, fractal turbulence that populate the attractor's spiraling, inner core. It is precisely this layering of predictability and unpredictability, or homeostasis and chaos (achieved, in this instance, through the system's interpenetration of itself, or what Karen Barad terms "self-touching" (2017, 80)), which distinguishes it for the viewer as an embodied "system". Mathematician Steven Wolfram tells us that "it is the computational equivalence of us as observers to the systems in nature that we observe that makes these systems seem to us so complex and unpredictable" (Wolfram, 2002, 844). In other words, it is the human's similarities with the systems it observes which creates the possibility of its being able to recognize them as such, suggesting that Kolmogorov's attractor bears a nontrivial resemblance to the human.

Still to be addressed in our VAK deconstruction is the source for the system's overall morphology. Here we turn to philosopher Clark and his complexification of Luhmann's boundary-drawing operation, or that initial move on the part of the self-organizing system which leads to its ability to distinguish its interior from its exterior environment. In Clark's revision of this operation, factors other than a system's ability to make such a distinction prove to be of at least equal importance, paramount among these being the relationship between the observer and how they choose to define the observed system. In terms of cognitive systems, Clark believes it is necessary to include in any such definition the memory and computational aids that support a given system's behavioral competence as well as any other features of its external scaffolding which support this competence.

He also recognizes the need to include time and scale factors when making determinations about system boundaries as often it is the interaction and/or imbrication of both "things" and "processes" which will define a system. As an example of such a system, Clark describes a fish coupling with its aquatic environment:

> The extraordinary efficiency of the fish as a swimming device is partly due, it now seems, to an evolved capacity to couple its swimming behaviors to the pools of external kinetic energy found as swirls, eddies and vortices in its watery environment. These vortices include both naturally occurring ones (e.g., where water hits a rock) and self-induced ones (created by well-timed tail flaps). The fish swims by building these externally occurring processes into the very heart of its locomotion routines. The fish and surrounding vortices together constitute a unified and remarkably efficient swimming machine (Clark & Chalmers, 1998, 32).

As applied to the system known as the Vague Attractor of Kolmogorov, we can see how this time/scale dependent perspective might allow it to be viewed as more than simply an interference pattern, a mere ongoing effect of the interactions of the Sun and planets. It could be viewed perhaps as the "digestive tract" of a ghostly, autopoietic system at the level of a solar system or galaxy, deriving energy for the whole from the asteroids that pass through it; or as an allopoietic system (e.g., one not primarily involved in reproducing its organization) which stands in relation to the asteroid belt system as a vacuole to a cell; or as a sub-subsystem of the Sun/Mars/Jupiter system, whose functioning at any level remains obscure due to these systems' remove from our own (in terms of scale/time frame). In each alternate reading, we get a sense of how a system's boundaries might be considered to be "a fact not a datum" (Salthe, 1985, 30), its reified qualities coming into view only as the observer's frame of reference pulls back in the spatiotemporal field. What is suggested in this interpretation is that there exists no privileged temporal or scalar position from which to judge the boundaries of a system. The latter will always be an artifact of the viewers' position within an imagined ontological hierarchy.

But doesn't taking such a view reintroduce Haraway's notion of the disembodied 'conquering gaze from nowhere' from which posthumanists are trying to escape? Anyone assuming such an imaginary positionality in hopes of being better able to grasp the relational aspects of systemic boundaries might readily be accused of trying to find, as Haraway describes it;

> a way of being nowhere and everywhere equally. The "equality" of positioning is a denial of responsibility and critical enquiry. Relativism is the perfect mirror twin of totalization in the ideologies of objectivity; both deny the stakes in location, embodiment, and partial perspective (Haraway, 1988, 584).

Surely, this move to interject spatiotemporal concerns into posthumanist discourse reflects yet another thinly veiled attempt to disembody the observer and avoid the limitations and responsibilities that accompany the assumption of a locatable positionality. Such theoretically inspired investigations, Luhmann notes, are always vulnerable to accusations of "a lack of practical reference" in that they do not "provide prescriptions for others to use" (Luhmann, 1989, xviii).

But while it is true that this approach does not offer a program for the dismantling of the liberal status quo directly, it does seek to further weaken the latter's epistemological underpinnings by making the role played by the observer in the construction of the observed more explicit. One of philosophy's prime underpinnings which continues to lend this outmoded epistemology political force is our largely unexamined acceptance of our own hierarchical reading of our relationship to other ontological scales of existence reified both by science and the major monotheisms; all systems existing at scales smaller than our own are considered to be, by definition, less complex, while those which exist at larger scales, e.g., extraterrestrial bodies/systems, are deemed to be too remote or disarticulated to warrant such considerations. By pointing out that "[t]he presence of scalar differences…follow[s] from the qualitative fact of the fixed position of an observer at a given scale" (Salthe, 1985, 41), the thought experiment presented here emphasizes the relative nature of our time/scale determinations.

It further suggests that if we are to fulfill the posthumanist imperative that our epistemo-ontological models incorporate the self-reflexive viewer within the observational frame, then we must be prepared to untether ourselves from this last, imagined, stable point of reference and accept the possibility that our scale of existence is but one among an indefinite number stretched out along (and within) a self-reflexive, self-similar, "self-touching" holarchical continuum. While this might seem to contradict scientific evidence for upper (galactic supercluster) and lower (Planck's constant) scalar limits, the question of scalar bounds is still an open one according to theoretical physicists, such as John D. Barrow:

> At present it is fashionable to believe that there is a 'bottom' line in fundamental physics: a basic collection of indivisible entities obeying a small number of mathematical rules in terms of which everything else can in principle be described. But the world may not be like this. Like a sequence of Russian dolls, there may exist an unending sequence of levels of complexity, with very little (if any) evidence of the next level down displayed by each of them (Barrow, 1998, 99).

And Karen Barad:

> To ask whether it is not suspect to apply arguments made specifically for microscopic entities to the macroscopic world is…to mistake the approach as analogical. The epistemological and ontological issues are not circumscribed by the size of Planck's constant (Barad, 2007, 70).

Referring back to Haraway's concerns about the ethical implications of relativism, we can now see how "[t]he dangers of relativism [in ***ethics]*** are vitiated to the extent I realize my interdependence with other beings: I shall indeed love my neighbor as myself when I experience that I ***am*** my neighbor" (Loy, 1993, 484), as the continuum model of the cosmos presented here (inspired by Spinoza's monist metaphysics and Barad's "agential realism") implies. Rather than providing a "conquering gaze from nowhere," this model permanently forecloses the possibility of any such positionality as it denies the existence of any 'outside' from which to look in.

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