physicist. In quantum physics, no phenomenon is an actual phenomenon until it is observed and agreed upon by all the physics colleagues. The story just as well illustrates the world of social interaction.

« 89 » My thesis is that all attempts to find stable knowledge of the world are attempts to find theories accompanied by eigenforms in the actual reflexivity of the world into which one is thrown. The world itself is affected by the actions of its participants at all levels. One finds out about the nature of the world by acting upon it. The distinctions one makes change and create the world. The world makes those possibilities for distinctions available in terms of our actions. Given this point of view, one can ask, as one should of a theory, whether there is empirical evidence for this idea that stable knowledge is equivalent to the production of eigenforms. In this case we have only to look at what we do and see that whenever "something is the case" then there is an orchestration of actions that leaves the something invariant, making that something into an eigenform for those actions. The eigenform thesis is not itself a matter of empirical science. It is a matter of definition, albeit circular definition. Another point of view is that the empirical evidence is all around you. Examine any thing. How does it come to be for you? Investigate the question and you will find that thing is maintained by actions. The action could be as simple as opening your eyes and looking at the cloudy sky. With that action, the cloudy sky comes to be for you. I do not assert that this is the usual scientific explanation of cloudy sky. But if you want to work with such things then it is usually even more transparent. The sharp spectral lines of helium are the result of setting up a very particular experiment that produces them. The experiment, its equipment, the scientists and all that is needed to perform it is the transformation whose eigenform is the spectrum of helium.

« 90 » It is a fruitful beginning to look at present scientific endeavors and to see how they are interrelated and find connections among them, to engage in meta-scientific activity. This can reveal how theories, seemingly objective, actually affect the world through their very being, and how these actions on the world come to affect the theories themselves. In exploring the world, we find regularities. It is possible that these regularities are our own footprint. In the end we shall begin to understand the mystery of the eigenforms that we have created, constructed and found.

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Open Peer Commentaries

on Louis Kauffman's "Cybernetics, Reflexivity and Second-Order Science"

Remarks From a Continental Philosophy Point of View

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> Upshot • The commentary focuses on some similarities between Kauffman's remarks on reflective, self-referential science, Kant's "Copernican turn" and the historicization of knowledge within "continental philosophy."

« 1 » For me, the great merit of Louis Kauffman's target article is that it brings together – intentionally or not – abstract mathematical and logical formalism with philosophical reflections ranging from everyday-life experience to scientific experience through second-order cybernetics. The article tries to support two interlocked theses within a mathematical framework. The first states that scientific observers always observe themselves, at least in some way. The second says that the observed objects depend on their observers, insofar as they are shaped by the observation (§4). From my point of view, there is nothing to reject. Maybe one could add that the observers are also shaped by the forms and categories with which they observe their objects and subsequently by the knowledge about them – but this is another discussion I do not want to enter into here. Instead, I want to draw attention to some striking similarities between "classical" philosophical approaches, Wittgenstein aside, and the statements in Kauffman's article.

« 2 » Being trained in philosophy of science and formal logic, and being especially familiar with George Spencer Brown's *Laws of Form* (1969), but thinking and doing research in the field of continental philosophy, I want to make two remarks:

a Kauffman's proposition seems to be an attempt to bring Immanuel Kant's "Copernican turn" into the (self-)reflections and descriptions of science (in its narrow sense);

b Kaufmann's interpretation of "eigenform" can be seen as Kant's figure of

> transcendental *conditions of the possibility of the knowledge* of the things we can have experience of.[1]

If (b) obtains, it might help to bridge the – pretended – gap between analytic philosophy, which understands itself as being based on scientific methods, including the conviction that an *independent* "real reality" exists that is *as such* knowable by analysing language, and the "continental" philosophy, which is judged – from the analytic side – as nonscientific because of its "relativism." This judgement derives from its reflexive attitude, called "critical" by Max Horkheimer (1975), Michel Foucault (2007) and others, of taking its own historical dependence and therefore *always* constructed standpoint into consideration.

« 3 » Unfortunately, this commentary is not the place to reconstruct Kant's transcendental philosophy or even his transcendental reflection, which is shown and described in his *Critique of Pure Reason* (1781/1787). Rather, it must be sufficient to explain the Kantian meaning of "transcendental," which is different from its use as "transcendental argument" or "transcendental reason" as, e.g., Ross Harrison (1998: 452) defines it. As pointed out in §2 above, Kant calls the structures ("elements") of our thinking *transcendental,* which make our experience, i.e., primarily the perceptions of things *as different things* in a world, *possible*. These elements are the two "forms of intuition," space and time, and twelve categories called "pure concepts of understanding." After Kant, these categories order spontaneously the manifold impressions that is given by our senses through space and time as phenomena. So how we present the "world" to ourselves while making experience depends on our instruments of observation. Everything we discover, e.g., connections or relations, we discover as such because our minds provide *a priori* a categorical ordering set *arranging* the phenomena this way. This is *in nuce* what Kant refers to, talking about Copernicus: "Hitherto it has been supposed that all our knowledge must [go by] its objects." Instead, Kant proposes to assume "that the objects [have to go by our concepts]" (KrV: B XVI, my translation[2]). Discussing our concept of "causality," Kant is even more explicit when saying that "we are able to extract […] pure concepts from experience only because we have put them into experience, and so have first brought experience about through them" (KrV: A 196/B 241,[3] Kant 2007: 217). This could be linked to Kauffman's "theory inevitably affects the ground it studies" (§9), but we need to make this more obvious.

« 4 » Transcendental concepts or forms *are* ordering structures of our minds that provide the possibility to make experience of different things, events and connections between them. If they were not given (in one way or other) or if we did not bring them with us, we could not make experiences in the way we do. This is what makes transcendental concepts necessary in the sense of being undoubtable. But these forms not only shape our experience, they also correspond with Kauffman's "eigenform" insofar as they make the "transcendental reflection" possible, i.e., the critical, purifying and scientific reflection and observation Kant himself undertook or realized while writing his book. Kant's self-observation iterates the observing relation between the understanding and its objects by using the same observation and ordering instruments and by dividing itself into an observed part, "the understanding," and an observing part, which is called "reason." Thus the set of ordering instruments found by the reflecting reason to be necessary for experience is also necessary for its own reflective practice, for its own being. Self-observation and object-observation depend on the same structures or forms. With Kauffman (§14), one could say that philosophy, too, has been searching for its "eigenform" in a reflexive field. Even more, one could add that Kant's transcendental reflection as the "objective result" has significantly changed the world of social science since then – at least if we follow Foucault's (1994) interpretation of the philosophical event at the end of the 18th century that might be called the "transcendental turn." Or, as Judith Butler puts it more generally: "But we must also have an idea of how theory relates to the process of transformation, whether theory is itself transformative work that has transformation as one of its effects" (Butler 2005: 2004).

« 5 » What does this kind of observation imply? From my point of view, one can see, in accordance with Kauffman, that philosophical research is also self-referential and reflexive, and that it has not only provided the necessary conditions for making experiences but has also shaped our experiences as well as its own research contexts. From this (Foucaultian) perspective,[4] humanities as an *effect* of the philosophical transcendental turn that reflects *on our own* as human beings as the condition of knowledge *at all* evolved in the self-creating and self-discovering "transcendental era." This self-reflection can be seen to have been rediscovered by mathematics and formal logic more than a hundred years ago. Yet it is well known that in those times, self-referential structures were avoided due to the paradoxes *negative* self-references produce (e.g., Tarski's "theory of types" as a strategy of avoidance). The grounding of mathematics in Spencer Brown's *Laws of Form* (1969) and Kauffmann's reference to it in §§41–44 could be seen as the second step of re-discovering the self-referential structure of science (and thinking in general). Spencer Brown not only deals with negative self-referential figures by interpreting the moving within the paradox as creating time (Spencer Brown 1969: 58–68), he also found a very concise way of making self-referential processes and thus self-referential creations obvious on the

1| "Ich nenne alle Erkenntnis transzendental, die sich nicht sowohl auf Gegenstände, *sondern mit unserer Erkenntnisart von Gegenständen, insofern diese a priori möglich sein soll,* überhaupt beschäftigt." (Kant KrV B 25, emphasis in the original) – "I call all knowledge *transcendental* which deals not so much with objects as with our manner of knowing objects insofar as this manner is to be possible *a priori*." (Kant 2007: 52, emphasis in the original).

2| "Bisher nahm man an, alle unsere Erkenntnis müsse sich nach den Gegenständen richten […] Man versuche es daher einmal, […] daß wir annehmen, die Gegenstände müssen sich nach unserem Erkenntnis richten."

3| "Es geht aber hiermit [den reinen Verstandesbegriffen] so, wie mit anderen reinen Vorstellungen a priori (z. B. Raum und Zeit) die wir darum allein aus der Erfahrung als klare Begriffe herausziehen können, weil wir sie in die Erfahrung gelegt hatten, und diese daher durch jene erst zustande brachten."

4| The subtitle of Foucault's *The Order of Things* is *An Archeology of the Human Sciences.*

basis of a single self-referential sign, ⌐, marking at the same time itself, its other, therefore identity and difference, and the *process* of its own coming into being.

« 6 » But, I am not convinced that the search for "eigenforms" *is necessarily* the driving force of science, though. Of course, it is needed as long as we think we have to search for structures, rules, concepts, laws, etc. that verify themselves. But as soon as we accept that it is us who (want to) find regularities, rules, patterns, etc. in our ordering mind because we draw distinctions by observing our objects and ourselves, we will see that we do not need to focus on what we have already ordered and how we have ordered it, but can also focus on our fantasy and the power of inventing new ways of thinking. Maybe the truth created by self-referential congruence is not the one and only criterion for valid knowledge.

« 7 » Coming back to my expectation that Kauffman's observations might help to bridge the "gap" between analytical and continental philosophy, I was wondering: if mathematics *and* formal logics could show that science is always self-referential then this would be valid for *every* philosophical standpoint – even for the "analytical" one. If we interpret self-reference in philosophy as the fact that philosophical theories are *always* socio-cultural-historically based, i.e., *shaped* in form and content by their times, too, as Hegel (1986: 15–20), Jean-Paul Sartre (2016), Horkheimer (1975), Foucault (2005) and other contemporary continental philosophers claim, then one of the defining differences between those two philosophical movements will disappear. Even the second difference concerning the status of language, which is seen to represent an independent world, will disappear if we follow Spencer Brown's idea that signs always (also) describe the distinction made by them. To show this in detail requires more space than a commentary, but Kauffman's article is a good starting point.

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Finally Understanding Eigenforms

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> Upshot • One of cybernetics most confusing and least understood concepts is that of the eigenform. With this article Kauffman has enabled a clear understanding of the concept as "the coherence of a situation that allows a distinction to be made."

« 1 » Louis Kauffman's target article is but one of many where the concept "eigenform" (Foerster 1981) gets used. I must confess that despite my serving as the President of the American Society for Cybernetics, and despite nearly two decades' work in cybernetics, I have found this concept to be among cybernetics' most difficult. At its heart, an eigenform is a "stability" – and, like many other examples of circular logic, the meaning of that stability supposedly becomes apparent with use. Until this article by Kauffman, I can woefully confess, such usage failed to ascribe much meaning, at least to me.

« 2 » In an earlier article (2005), Kauffman suggested that the notion of an eigenform was related to the idea that "an object is a symbolic entity, participating in a network of interactions, taking on its apparent solidity and stability from these interactions" (Kauffman 2005: 130). The eigenform is an expression of that stability:

> "Heinz von Foerster has suggested the enticing notion that 'objects are tokens for eigenbehaviors.' There is a behavior between the perceiver and the object perceived and a stability or repetition that 'arises between them.' It is this stability that constitutes the object (and the perceiver)." (Kauffman 2005: 132)

« 3 » Philosophically, this notion of stability is troublesome. "Stable with respect to what?" becomes an obvious question. The von Foerster answer of "between object and perceiver" sheds little light on this matter. In my view, it leaves out the context in which the network of interactions is situated. To me, there can be no stability except in consideration of the context, but that transforms the notion of an eigenform into at minimum a three-way interaction amongst object, perceiver, and context and, given the possibility of multiple perceivers each with their own context, at maximum an infinite interaction. If, indeed, an eigenform is possibly the product of an infinite network, then how is it possible for that product to be "stable?"

« 4 » Kauffman continues:

> "Coalesence connotes the one space holding, in perception, the observer and the observed, inseparable in an unbroken wholeness. Coalesence is the constant condition of our awareness. Coalesence is the world taken in simplicity […] In the world of eigenform, the observer and the observed are one in a process that recursively gives rise to each." (Kauffman 2005: 133f)

« 5 » At this point, the circular logic tends to defeat me. Stability, as a product of recursion, in the absence of consideration of context, is beyond my reckoning. Kauffman's present article rescues me by restoring the notion of context to the understanding of eigenforms generally. As he states: "a reflection on the context, and an inclusion of that awareness of context into the context is always present" (§1).

« 6 » The key to understanding is located in §3: "A reflexive domain is a context