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The Logic of Hegel's *Philosophy of Nature* Nature, Space and Time

by *Edward Halper*

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The philosophy of nature is the most difficult portion of Hegel's system. Besides the extensive scientific development since Hegel's time far beyond what he could have imagined--there has always been skepticism about his conceptual grasp of the science of his own era. His notion of a systematic conceptual development would seem to be at odds with the way that natural science actually developed and his accounts of one concept's "passing over" into another are, of all the parts of his system, perhaps least instructive for grasping the development or content of scientific concepts. Indeed, a conceptually complete system is strikingly at odds with what the contemporary world values most about science: its power to grow and correct itself, sometimes radically. This essay will address the seeming irrelevance of Hegel's *Philosophy of Nature* to modern science, but not by showing that Hegel's concepts are important to scientific practice. What really needs explaining is why he would think that a purely conceptual system could constitute genuine scientific knowledge of nature. Ironically, on this issue, it seems to me that the greatest obstacles to appreciating Hegel's *Philosophy of Nature* are internal questions about its character as a conceptual system, and it is such questions that I shall pose and consider here. My contention is that seeing how to resolve these problems will put us in a position to see that Hegel is himself addressing the most persistent of all objections to his system: how there could be a philosophical treatment of nature. That is to say, the objection made to Hegel's system of nature is the very difficulty he himself addresses: the indifference or externality of nature to conceptual determination. I shall return to this point in the final section of this paper. For now, the internal problems.

First, though Hegel's *Philosophy of Nature* belongs to a conceptual system that is supposed to be both self-contained and self-generating, many scholars persist in speaking of its categories as if they were merely *logical* categories applied to some new non-conceptual content or were merely concepts imported from the science of his day.¹ But a fully systematic development could admit of nothing imported from outside. In an idealism like Hegel's, there is nothing non-conceptual to which

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could be applied. The problem for us is, thus, how the philosophy of nature could belong to an idealist conceptual system.

A second, closely connected problem is how to understand the concepts of the philosophy of nature. What, in particular, distinguishes the categories of nature from those of logic? Philosophy of nature comes after logic in Hegel's system, but it is puzzling how there could be another branch of the system after logic reaches its pinnacle in the absolute idea. How could there be new non-logical categories? Either conceptual development beyond the absolute idea is impossible, or such development would seem to produce new *logical* categories. This difficulty could be resolved by adding some non-logical content to the categories of logic to generate the categories of nature. But, again, the addition of something external would undermine the system's idealism and its self-containment. The categories of nature must thus be, on the one hand, distinct from those of logic and, on the other, generated from logical categories. But even if there were somehow a new category after absolute idea, why would it not remain a logical category?

A third problem with philosophy of nature is how the categories of nature transform themselves into new categories. I have argued elsewhere that the categories of logic are transformed by processes of self-relation: Hegel shows that particular categories are themselves instances of the conceptual content they contain, but this self-determination adds new content to the category and so transforms it into another category.² The process differs for different categories, and differs significantly in different spheres; but it allows logical concepts to be generated without introducing additional non-logical content. Are the processes that transform the categories of nature into new categories the same as those that transform the categories of logic? If categories of nature were also transformed by self-determination, then, in this respect, too, they would not differ from logical categories, and the philosophy of nature would either be a branch of logic or altogether superfluous. If, on the other hand, the process of development of the categories of nature does *not* involve self-determination, it is hard to see how it could be self-contained and not rely upon additions from outside the system. In short, in respect of both their character and the process of their development, the categories of nature either reduce to those of logic or undermine the systematic and idealistic character of Hegel's philosophy.

The best way to understand how philosophy of nature can be systematic is to resolve the second and third problems. Let me, thus, begin with the second problem, the character of the categories of nature and their difference from those of logic. Discussing the culmination of logic, absolute idea, in the final pages of the *Science of Logic*, Hegel characterizes it as both the product of the entire preceding conceptual development³ and as a concept that contains this development within itself.⁴ (These are, respectively, its form and content.) What makes absolute idea the culmination of logic is that, unlike other categories, it does not transform itself into a new concept; and the reason for this is that it already contains its own transformation. In other words, because the absolute is a self-unfolding of all the categories, transformation does not affect it; its nature is transformation. In Hegel's terminology, the content of the absolute idea is the "method" of its conceptual transformations, but the totality of this "method" is also the distinctive character of absolute idea, its form; hence, absolute idea's content is

identical with its form. Once the conceptual development that constitutes logic reaches absolute idea, it immediately begins to unfold again. Thus, logic completes itself by returning to itself.

Hegel's image of the absolute idea is a circle that includes the whole of logic.⁵ This image conveys the closure of logic, a closure that makes it puzzling how the system can contain other parts. Yet, ironically, it is also the recognition of logic as a kind of circle that Hegel thinks makes the other portions of the system possible.⁶ Though his discussion of the emergence of the sphere of nature is somewhat obscure, it seems that the basis for this sphere lies in the same distinction within absolute idea that Hegel draws upon to assert its completion: that between its form and content. Again, the content of absolute idea is the conceptual transformations between all the logical categories, and its form is just its character as a particular category. Absolute idea is the culmination of logic in so far as its form is identical with its content; that is, in so far as its individuality is just the totality of the transformations of all categories. However, it is also a category that is distinct from all other logical categories: it is a single universal that differs from the logical categories contained within it and from their complex conceptual development. In this latter respect, absolute idea is indifferent and external to the processes of conceptual unfolding that constitute logic. It is precisely this *externality* of absolute idea's form from its content that defines the realm of nature.⁷ So it is that absolute idea, in being just what it is, is also something else. Alone among all the logical categories, absolute idea does not develop; it is its own self-unfolding. Yet this self-unfolding that is its content can be distinguished from the concept it defines, a concept that is external to its own content. It is the very closure of logic that opens the possibility for a treatment of nature.

This account is entirely consonant with Hegel's well-known image of the system:

[S]cience exhibits itself as a *circle* returning upon itself, the end being wound back to the beginning, the simple ground by the mediation; this circle is moreover a *circle of circles*, for each individual member as ensouled by the method is reflected into itself, so that in returning to the beginning it is at the same time the beginning of a new member. Links of this chain are the individual sciences [of logic, nature and spirit], each of which has an *antecedent* and a *successor*.^[8]

In the absolute idea's returning to itself, it completes a circle that is both itself and something else.

What is this other? It is important to see that it is not a *new* logical category, but an additional logical category. As Hegel puts it,

The Idea, namely, in positing itself as absolute *unity* of the pure Notion (*Begriff*) and its reality and thus contracting itself into the immediacy of *being*, is the *totality* in this *form-nature*.^[9]

In other words, the conceptual development that constitutes the content of the absolute idea along with the simple immediate (category of being that constitutes its form comprise together a "totality" that defines the realm of nature. This form of the absolute idea does not merge with it to engender a new, more complex category--there is no further logical development beyond

absolute idea. We are not dealing with a new logical category, but with a plurality of logical categories, a "totality." The category of nature consists of two constituent logical categories, absolute idea and its determination, being. The constituents remain indifferent to each other and thus comprise an irreducible composite.

This is an extraordinarily simple idea, but one looks hard to find it expressed anywhere in the literature. Again, the absolute idea that completes logic turns back upon itself, and this simple self-identity makes it an instance of the category of being. But the being that absolute idea acquires in returning to itself, that is, in being what it is, remains distinct from the being (the first logical category) that belongs to its unfolding. This acquired being is added to absolute idea, and the result is two categories yoked together: this is nature. In being what it is, absolute idea is something else--a being--and this being remains distinct from and indifferent to it. This explains how the completion of the circle that constitutes logic is also the beginning of the circle that constitutes nature.

It may seem odd to speak of logic's first category, being, as a predicate, but all Hegelian categories are both subjects and predicates. Or, better, they are completely general conceptual determinations that could characterize anything, including themselves. This possibility of applying categories to themselves and to other categories is crucial if the system is to be self-contained.

A composite of two logical categories, the idea of nature adds nothing to logic. As we saw, the new determination, being, stands outside the conceptual development that is the absolute idea. Though being and absolute idea are both external to each other, it is the externality of being that Hegel seems to have in mind when he characterizes nature as externality in the *Philosophy of Nature* (EN [1830], ?47); for it is the *determinations* of absolute idea that have the characteristics of space and other natural categories, as we will see. The emphasis in the *Philosophy of Nature* is always on absolute idea's determination rather than absolute idea, and it is easy to see why. Since absolute idea is already fully determined, anything that is added to the totality of it and its determination could only be a determination of its determination. Thus, a determination of the concept of nature could only transform being, the determination of absolute idea. Indeed, we could expect this determination to be transformed into nothing and then into becoming, and the entire sequence of the *Logic* to repeat itself. With many qualifications, this is what we see in the *Philosophy of Nature*. In characterizing the concept of nature as absolute idea determined as a being, Hegel contrasts it with the absolute idea with no determination. Hence, the determination of absolute idea is not only simple being but also the negation of being: nothing. As such, nature becomes a determinate being (*Dasein*) (?48). In its initial stages, then, the development of the concept of nature is the development of its determination, and, as we will see more clearly shortly, this development parallels the opening moves of the *Logic*.

It is important to remember that Hegel is not dealing with logical categories here. Nature is not the category of being, but being attached to absolute idea, and the presence of this latter component is important not only to distinguish logical and natural categories, but also, as we will see, for the latter's transformations. According to my interpretation, just as logic is

the self-unfolding of the categories, so, too, nature is the beginning of a kind of second-go-round of the same concepts, now with absolute idea attached to them. The rest of Hegel's system completes this second coming, as it were.¹⁰

This distinction between logical and natural categories provides a solution to the second of the three problems mentioned above, and the account advanced here also resolves part of the first problem: since nature includes no new categories beyond what logic makes available, there is no need to import any non-conceptual content into the system or to give up its self-containment. The new realm emerges from conjunctions of already developed logical categories.

Categories of Nature

Thus far I have focused mainly on the transition to nature that Hegel presents in the final pages of the *Science of Logic*. It is time now to look for evidence for this account in the *Philosophy of Nature*. Since Hegel never worked out this portion of his system in detail, we are forced to rely on the often sketchy *Encyclopedia*. In this section I shall show that the account of nature just derived from the *Logic* can also be found in the *Philosophy of Nature*. This understanding of the realm of nature helps to explain what would otherwise seem to be only scattered remarks on the concept of nature that open the second part of Hegel's *Encyclopedia*.

Paragraphs 245 and 246 both emphasize the presence of the concept (*Begriff*) in nature. In the former, Hegel claims that the concept is immanent (*immanent*) in nature;¹¹ in the latter, he speaks of nature as a self-determined concept.¹² These characterizations would seem incompatible; for if the concept is "immanent in nature," then nature is *more* than just the concept, and it is wrong to identify nature with the concept. However, the characterizations become intelligible when we reflect on the end of the *Logic*. The concept that is both immanent in nature and self-determined can only be the concept taken over from the preceding stage of the system, from logic. That concept is, of course, the absolute idea. Nature, as we have seen, is just absolute idea in its immediacy, that is, absolute idea determined as a being. Thus, absolute idea is at once merely immanent in nature and, in so far as it is nature's content, identical with nature; it manifests itself in nature and constitutes nature.

On the other hand, nature is not simply absolute idea, but this idea with an additional determination. As I said, since absolute idea is already complete in itself, any additional determination would be external to it. So it is that Hegel insists in ¶47 that nature is characterized by its externality. The idea of nature contains two components that remain external to each other. As Hegel says in ¶48, the determination of the concept is isolated from it, though the concept remains present as "something inward."¹³ Significantly, in the remark that accompanies this section, he refers to the determination as "being"; the concept determined can only be the absolute idea.

This conception of the idea of nature makes intelligible Hegel's preliminary account of the development of nature in ¶249-52. In ¶49, he calls nature a "system of stages, one arising necessarily from the other ... not generated *naturally* out of the other but only in the inner idea which constitutes the ground of nature." The "inner idea" is, again, absolute idea, and Hegel's point is that it

is successively determined by other categories and that these determinations spring from it rather than from each other. Thus far, absolute idea has been determined as an "immediate being."¹⁴ Yet, this scarcely does it justice. The determination's inadequacy to the concept it is supposed to express constitutes the basis of an inner dynamic.¹⁵ To characterize absolute idea simply as an immediate being is to falsify it. Absolute idea is, rather, different from this determination. It is better grasped without any determination, but to grasp it as such is to determine it as nothing. In so far as absolute idea is and is not its determination, it is a determinate being (*Dasein*). I think it significant that Hegel refers to nature as a determinate being in ? 48 while distinguishing the concept from its determinations. These initial determinations consist of the opening categories of the *Logic*. As we will see, the determinations are not generated from each other as in the *Logic*; rather they arise from absolute idea. In respect of absolute idea they are necessary; in relation to each other, the determinations are contingent "properties" (? 50).

It is clear that characterizing absolute idea as a determinate being is only slightly more adequate than characterizing it as a being. The conceptual development within the sphere of nature aims to overcome this externality and generate a determination adequate to the absolute idea. What is needed is a determination that would match the idea. Moreover, any determination that would remain external to the idea would fail to capture its all encompassing character. To overcome this externality, the determination must belong to the idea; it must be a determination that the idea gives to itself. To give itself its own determination and remain what it is defines the logical category of concept (*Begriff*).¹⁶ If nature posits its determination as what it is in itself, and then returns to itself; it will overcome externality. But this movement would at once determine it as belonging to spirit (?51). Thus, the truth of nature lies in the next realm of the system, spirit. It is in respect of this end that Hegel marks off the divisions of nature in ?52. He describes them as moments of the concept: universal, particular, and individual (see also ?52 Zus.). Though Hegel uses these categories in his treatment of nature, most often it is categories from the earlier portion of the *Science of Logic*, the Objective Logic, that he draws on to do the conceptual work of the *Philosophy of Nature*. Since nature consists of the absolute idea with its additional determination, and since the absolute idea is a concept, Hegel is entitled to speak of the idea of nature as a concept. It is only the additional determinations of that concept, not the idea of nature as a whole, that belong to the categories of Objective Logic.

Though Hegel clearly uses logical categories to characterize the categories of nature, deciding which logical category defines a category of nature is not always easy. He identifies space as a universal characterized only by its self-externality, its self-otherness (?54 Ann.); and time he calls the negativity of this otherness, a being that is "for itself" (?57). Otherness is one of the logical categories of the sphere of determinate being. Hegel characterizes time as the transition from being to nothing and from nothing to being, that is, as becoming, the category that precedes the logical sphere of determinate being (E258, 259). The synthesis of space and time yields the categories of place and motion, both of which are defined as transitions or becomings of space into time and time into space, that is, as negations of negations (E260, 261). Similar characterization as negation of negation defines the last logical categories of the sphere of determinate being, finite and infinite,¹⁷ though Hegel

does not mention them in this portion of the *Philosophy of Nature*. Thus, the first section of *Mechanics* would seem to employ the logical categories of the sphere of determinate being, roughly in their logical sequence.

The categories of the remaining two portions of *Mechanics* are characterized through the next set of logical categories, those of the sphere of being-for-self. Thus, in the second portion matter is a being-for-self (E262, 263 Zus.),¹⁸ a body is a one (?64), and the relation between bodies is repulsion (?68). The third portion of *Mechanics*, *Absolute Mechanics*, focuses on gravity, and the interaction of attractive and repulsive forces, clearly drawing on the logical categories of the third portion of being-for-self. If all this is right, then the categories of the first division of nature are defined with, or at least correspond to, the logical categories of the spheres of determinate being and being-for-self.

Though well supported by the text, there is at least one apparent problem with this association of logical and natural categories. According to the proposed alignment, space and time are instances of determinate being. But Hegel insists, in his remark to ?54, that space is *not* a quality but pure quantity.¹⁹ The reason, he explains, is that unlike the *Logic* where the first determination is "abstractly First and immediate," the first determination of nature is "a Being already essentially *mediated* within itself, an external- and other-being." What he apparently means is that since the first determination of nature is a determination of a concept, the absolute idea, it cannot be simply immediate but must be distinct from this concept, and precisely such a distinction, with the independence and indifference of its moments to each other, is the mark of the quantitative.²⁰ With these two moments so distinguished, nature is space, and in its totality the idea of space is a quantity because its two moments, absolute idea and determinate being, are indifferent to each other. In other words, the entire idea is a quantity because one of its constituents is a determinate being.²¹ It is not contradictory for Hegel to say that categories of nature as *wholes* are quantities and that they are defined with categories from the logic of quality.

This reasoning shows some of the complexity possible in categories that are defined quite simply. Recalling an earlier point, I can add that the idea of nature also includes determinations from its other constituent, the absolute idea. Thus, as noted, Hegel refers to it as a concept and uses the categories of concept, universal, particular, and individual. Logical categories from concept, quality, and quantity provide Hegel with rich conceptual material with which to develop the idea of nature. His resulting discussion is often confusing, but the account offered here shows why it is legitimate to use categories from all three spheres.

Logical categories can be applied to experience or to the world, but if the categories are to receive a systematic and self-contained development, they should be applied to themselves. In the *Logic*, the application of categories to themselves generates new logical categories. Yet such an application of categories need not do so. Thus, the idea of space, absolute idea that is also a determinate being, is an instance of the category of quantity, but it is neither the logical category of quantity nor a new logical category. It is not identical with the category of quantity because quantity does not exhaust its nature, just as, a person has a size without being a quantity. The idea of space is not a new logical category because the categories that do define

it do not constitute a unity: categories of nature consist of non-unified pluralities of logical categories. The natural categories, at least the first group, as I have shown here, are constituted from the logical categories. They add nothing logically, but they present rich new pluralities of logical categories some of whose internal relations Hegel explores in the *Philosophy of Nature*. Significantly, the externally related constituents of natural categories mirror the externality that defines them.

Natural Transformations

The processes of transformation between logical categories are developed in the *Logic*. Since the categories of nature are composed of logical categories, we need to ask whether the transitions between natural categories are effected by the same processes of reasoning as those between logical categories. Are the transitions between natural categories logical transitions, effected by self-determination, or are they dialectical processes peculiar to the natural realm?

My account of the opening sections of Hegel's *Philosophy of Nature* suggests an answer to this question. Logic, the beginning of Hegel's system, can work only with being and what emerges from it. Thus, the determination of logical categories by logical categories is the only possibility. In the sphere of nature, though, the fully determined absolute idea is present and receives a further logical determination. This logical determination can itself be further determined, and the result is, of course, still another natural category. As we have seen here, it is important in the generation of the second determination that the first determination both be other than the absolute idea and fail to express it fully. The interplay between the two moments of natural categories, that is, between the absolute idea and its determination, constitutes a dimension not present in logic. Exploiting the difference between these moments, Hegel can develop a dialectic of nature that differs from the dialectic that generates logical categories, a dialectic based upon other-ness. To understand how it works let us look closely at the transitions between the opening categories of nature.

The first particular category of nature is space. This is, I have argued here, the absolute idea determined as a determinate being. Now the determination is not divided further; it has no differentia within. Hence, it is all alike (?54). However, it is distinguished from the concept (namely, the absolute idea). The determination is, then, at once indifferent within itself and different from the concept (?55). In being indifferent, space is different from its notion, absolute idea. In other words, the determination, determinate being, contains within itself no differentiation, and just this lack of difference makes *it* different from the other component of the concept of space, the absolute idea which is differentiated in itself. If, though, absolute idea's determination differs from it, then that determination is not absolute idea but its negation. Hence, the concept of space contains, as it were, its own negation, its essential difference from the absolute idea.

This first negation of space is the negation of its "differenceless self-externality." The determination that characterizes absolute idea cannot be all alike. The negation of "being all alike" is a determination of space. It cannot be a determinate place because there is nothing else, no other determinate thing, from which it would differ. Conceptually, the negation of space, the negation of being everywhere the same, is a particular

determination of space, a point.²² However, the point fares no better as a determination of the absolute idea than does space. In so far as the point is other than the idea, it also negates the idea; and, consequently, its expression of the absolute idea is also the negation of itself. This second negation adds additional content to the point. Thus, the negated point has more conceptual content than the point, and much more content than space. Hence, the negation of point, the double negation of space, cannot be space. But in so far as it negates the particular determination of space (the point), it is spatial. Without explanation, Hegel identifies it with the line. But the line remains other than the idea it is supposed to express; hence, to determine the absolute idea as a line is also to recognize it as other than the line, as the negation of the line. Again, this cannot be the point or space; Hegel just identifies it as bounded space, or figure.

These last conceptual moves come rather too quickly in the text. It is not clear, on conceptual grounds, that there should be successive negations of space or that they should be identical with line or figure. Nor is it clear that, once begun, the process should terminate at figure--Hegel's assumption of three dimensionality is particularly grating to those who have become accustomed to talk of multi-dimensional spaces. There is clearly a conceptual development that is omitted from the tersely argued *Encyclopedia* version of the *Philosophy of Nature*. Nevertheless, Hegel's main point is well-founded: there remains an insurmountable otherness between the concept, that is, the absolute idea, and the determination of determinate being that expresses it; and the more that we try to distinguish the concept from this determination as something other, the more we determine it as other and the more ways in which its otherness comes to be expressed. Ironically, the attempt to distinguish absolute idea from its determination results in new determinations of it--but determinations of the same sort, namely, determinations of otherness, spatial determinations.

This possibility of continuous otherness is precisely the concept of time. Space determines itself as point, line, and figure; the successive determination is also a successive negation, a continuous passing away. This self-negating otherness is time. The difference between space with its determination and time is that whereas the former preserves the determinations "next to each other," time is the succession of determinations. As Hegel notes, time is the negativity of spatial determinations (?57 Zus.). Time is the other side of the process of spatial determinations.

Since the determinations of space are continuously self-negating, time is something whose being lies in its non-being (? 58). The self-negating character of time makes it possible to distinguish what has already been negated (past) from what remains (future). Yet, the very same character renders any such distinction meaningless; for in so far as time is continuously self-negating, all its moments are alike (?59). Thus, it has just the character of space. That is to say, time, determined through itself, is space.

This identity of space and time is what Hegel terms "place" (? 60). Since, though, space and time are continuously self-determining, they are also continuously reconstituted: this change of place is motion. Conceptually, motion is the *process* of determination that continues as space and time negate themselves; it is the otherness of their identity, place. The latter, being itself other than motion, persists through the continual

negation of space and time. This determination of place as persistent (in a peculiar way) is just what Hegel terms "matter" (§61). Matter, in this sense, is simply the fullness of place in space and time, a fullness that is constituted by quantity itself. As Hegel explains in a note, these abstract determinations become concrete and real by being further determined.

In sum, the first categories of nature emerge through a dialectical development that follows from the otherness of absolute idea and its determinations. Though Hegel is not always as clear as he could be, the present section shows that these first categories do emerge in a rigorous way. Whereas the development of the categories of logic proceeds by *self-relation*, that is, by showing that a category is an instance of itself, the first categories of nature develop in virtue of their internal otherness, their *self-otherness*. Hence, philosophy of nature has its own characteristic mode of dialectic distinct from the dialectic of logic.

To show that the first categories of nature are derivable through a rigorous reasoning process does not, of course, prove that the rest are as well. Nor can we predict in advance the system's entire conceptual development: the reapplication of logical categories to the absolute idea is, by no means, wooden or mechanical. Still, the preceding shows that a systematic development of philosophy of nature is possible in principle. And it relies on the otherness that Hegel declares to be fundamental to this realm. More developed logical determinations will generate more developed natural categories.

Externality and Nature

It remains to consider why otherness, that is, externality, should be fundamental to the realm of nature. To say that externality is not widely recognized as a problem in natural philosophy or philosophy of science would be an understatement. Hence, it is not surprising that Hegel's concern to overcome it in his *Philosophy of Nature* has not aroused great interest. The fact that philosophy of science is so often dominated by empiricists and their heirs has, I suggest, rather obscured the issue. Some historical remarks can help us put it into context.

Recall that what Aristotle called science consisted of grasping the essential nature of a genus and demonstrating the attributes that belonged to the genus in virtue of that nature. Because the Principle of knowledge, the generic nature, resided in a genus, little or nothing could be said about interactions among different genera. Medieval thinkers, supposing that all such interactions were guided by a just and benevolent deity, opened up the possibility of knowledge of the entire world and of all its distinct genera as constituting an organic whole.²³ The laws governing these interactions resided in God's mind. Philosophers in the modern period removed the immediate effects of divine agency and tried to find the laws of nature in nature itself. This created enormous ontological problems; a history of their treatment would be a history of modern philosophy. Current discussions of this period often pose its central metaphysical problem as the relation of mind and matter, but what was the reason for modern philosophers' interest in this problem? Their assumption was that the laws of nature must be rational and intelligible but that what they govern, matter, is something of a completely different nature. How could something intelligible, a rational law, govern the inter-actions of material things?

It was, I suggest, concern to account for the relation of laws and matter that motivated much modern metaphysics. Descartes insisted that any law we could think clearly and distinctly must correspond to matter, and Spinoza also advanced a kind of correspondence between thought and matter, albeit a different one. Leibnitz located laws in matter; but in so far as each bit of matter contains all the laws, no law could govern the interactions between distinct bits of matter, nor could any bit of matter account for its inter-actions with other matter. Thus, Leibnitz had to give up on the possibility of interactions among different bits of matter; instead matter acts in pre-established harmony. Empiricists did not solve the problem; they reacted against the rationalists' solutions by noticing that science could get along without solving it.

The point of all this is that throughout the modern period the laws governing nature were understood to be ontologically distinct from the material they governed. This is, I suggest, Hegel's problem of otherness. It manifests itself quite clearly in the first categories of natural philosophy: space and time are determinations that are most distinct from the rational principles of thought, the content of absolute idea. Yet, Hegel insists that it is just such rational principles that generate space and time. The *Philosophy of Nature* aims to show that the rational principles are not outside of nature but somehow present within it. It is only if we could grasp the laws as existing within nature that we would be justified in regarding those laws as laws of nature. Laws that existed within nature would not be "other."

Aristotle's principles of nature lack otherness, but they are species essences that, as noted, do not account for interactions among species. A law that resided in any one bit of matter did not account for its interactions with other bits of matter. The law would somehow have to reside in all matter. The idea expressed by some contemporary physicists that the laws of physics were fixed in the first micro-seconds after the big bang avoids the externality of having laws outside of matter, but because these laws stem from chance arrangements of matter, they remain, to some extent, external. Hegel's aim in overcoming externality is to understand the laws of the universe to belong to what they govern. This question, how is the law related to what it governs?, is fundamental for any understanding of nature. If philosophers do not pursue this question, it is only because they doubt that we can truly grasp nature. Law is, of course, the logical component of nature; the absolute idea that is brought from logic into the realm of nature is the conceptual analogue of all laws of nature. The determinations that philosophy of nature adds to this logical component are the material constituents of nature. Though the material determinations are external to law/idea and initially in-adequate, they are successively determined until they come closer to expressing the idea. In this overcoming of externality, Hegel shows the possibility that thought about nature might genuinely express nature, and so answers the chief objection against him: nature admits of a conceptual treatment only if it contains reason, and this is precisely what *Philosophy of Nature* shows. Yet, ironically, in overcoming externality, in showing nature as the expression of laws or, equivalently, the determination as an expression of the absolute idea it determines, Hegel must determine the determination as the idea's own expression. In this case the determination the absolute idea receives would belong not to the logical realm of being, but to concept; and the complex of idea and the determination it gives itself would belong to spirit. So it is that in overcoming externality, thought passes over to the realm

Notes

1. After making (well justified) fun of remarks made by earlier commentators on the relation of logic and the rest of the system, M. J. Petry, *Hegel's Philosophy of Nature*, 3 Vols (London: George Allen and Unwin, 1970), 1: 40-1, describes his own view of the relationship: "The categories of the 'Logic' ... are an integral part of [natural and spiritual] phenomena, and yet, on account of their greater simplicity, universality or generality, and on account of the complexity relationships in which they stand to one another as categories, they have to be regarded as constituting a distinct sphere and as demanding treatment in a distinct discipline" (1: 42). This is true enough, but our expectation that Petry will explain the complexity of nature is frustrated. He only notes that the logical categories of measure and rule have manifold applications and then claims that there is a correspondence between the categories of logic and the "levels" of nature (1: 42-3). Space is the first of the latter, he claims, "simply because it was the least complex level recognized in the natural science of his day" (1: 46). Apparently, Petry also sees the *Philosophy of Nature* as some sort of application of logic and he gives up on its being a genuine system. But what are the "natural phenomena" to which logical categories are applied? What additional components make them more complex than the logical categories? Despite Petry's term, "level," these additions must clearly be conceptual. Yet, how could they be conceptual but non-logical?

M.J. Inwood, *Hegel* (London: Routledge & Kegan Paul, 1983), pp. 350-1, is right to reject this thinking as unsupported by the text. However, he himself is unable to explain Hegel's account at the end of the *Logic* of the transition from logic to nature; he ascribes it to "confusion" on Hegel's part (pp. 378-9). Though he goes on to discuss Hegel's arguments for the transition, he takes these from other parts of the system; consequently, they do not respect the system's integrity. Nor, indeed, does much of the rest of his discussion. Inwood's concern with whether "the world corresponds to [Hegel's] system" (p. 379) is a throwback to the notion of application he wishes to reject; for what is "the world" besides the totality of concepts? (Return)

2. See my "Self-Relation in Hegel's *Science of Logic*," *Philosophy Research Archives* 7 (1981): 89-133. See also my discussion in "Hegel and the Problem of the Differentia," in *Essays on Hegel's Logic*, edited by George di Giovanni (Albany, New York: SUNY Press, 1989), esp. pp. 196-202. (Return)

3. G.W.F. Hegel, *Wissenschaft der Logik II. Erster Teil: Die objektive Logik, Zweites Buch. Zweiter Teil: Die subjektive Logik*, edited by E. Moldenhauer and K.M. Michel, *Werke in zwanzig Banden*, Vol. 6 (Frankfurt am Main: Suhrkamp Verlag, 1969), p. 550; A.V. Miller, *Hegel's Science of Logic* (London: George Allen & Unwin, 1969), p. 825. (Hereafter cited as: *Logik* [*Werke*, 6], p. 550; Miller, *Logic*, p. 825.) (Return)

4. *Logik* (*Werke*, 6), pp. 552, 568-9; Miller, *Logic*, pp. 827, 839-40. (Return)

5. *Logik* (*Werke*, 6), pp. 570-1; Miller, *Logic*, pp. 841-2. (Return)

6. *Logik* (*Werke*, 6), p. 571; Miller, *Logic*, pp. 841-2. (Return)

7. *Logik* (*Werke*, 6), p. 573; Miller, *Logic*, p. 843. (Return)

8. *Logik* (*Werke*, 6), pp. 571-2; Miller, *Logic*, p. 842. There is another reference to philosophy as a circle of circles in the *Zusatz* that opens the *Encyclopedia's* treatment of nature: G.W.F. Hegel, *Enzyklopedie der philosophischen Wissenschaften im Grundrisse (1830). Zweiter Teil: Die Naturphilosophie. Mit mündlichen Zusätzen*, edited by E. Moldenhauer and K. M. Michel, *Werke in zwanzig Banden*, Vol. 9 (Frankfurt am Main: Suhrkamp Verlag, 1970), p. 10; A. V. Miller, *Hegel's Philosophy of Nature* (Oxford: Clarendon Press, 1970), p. 2. (Hereafter cited as: *EN* [1830]; *Werke*, 9: 10; Miller, *PN*, p. 2.) (Return)

9. *Logik* (*Werke*, 6), p. 573; Miller, *Logic*, p. 843. (Return)

10. Is still another circle possible? It would be conceptually more complex and richer than the system Hegel develops. Perhaps the derivation of Herr Krug's pen (*EN* [1830], ?50; *Werke*, 9: 35n.; Miller, *PN*, p. 23) awaits such a third coming. (Return)

11. *EN* (1830), ?45; *Werke*, 9: 13; Miller, *PN*, p. 5. (Return)

12. *EN* (1830), ?46; *Werke*, 9: 15; Miller, *PN*, p. 6. (Return)

13. *EN* (1830), ?48; *Werke*, 9: 27; Miller, *PN*, p. 17. (Return)

14. *EN* (1830), ?48 Anm.; *Werke*, 9: 27-8; Miller, *PN*, p. 17. (Return)

15. "Starting therefore from the externality in which the concept at first exists, its progress is ... a bringing of immediate and external existence, which is inadequate to itself, to subjective unity, to being-within-self," *EN* (1830), ?51 Zus.; *Werke*, 9: 37; Miller, *PN*, p. 25 (translation slightly modified). (Return)

16. *Logik* (*Werke*, 6), pp. 273-5; Miller, *Logic*, pp. 600-2. (Return)

17. G.W.F. Hegel, *Wissenschaft der Logik I. Erster Teil: Die objektive Logik, Erstes Buch*, edited by E. Moldenhauer and K.M. Michel, *Werke in Zwanzig Banden*, Vol. 5 (Frankfurt am Main: Suhrkamp Verlag, 1969), p. 162; Miller, *Logic*, p. 147. (Hereafter cited as: *Logik* [*Werke*, 5], pp. 162; Miller, *Logic*, p. 147.) (Return)

18. In a remark on matter (*EN* [1830], ?62 Anm.; *Werke*, 9: 61; Miller, *PN*, p. 45), Hegel directs readers to his remark on Kant's treatment that appears in the *Logic* among the categories of being-for-self (*Logik* [*Werke*, 5], pp. 200-8; Miller, *Logic*, pp. 178-84), further supporting the categorial alignment proposed here. In the *Logic* the remark comes at the end of being-for-self because it criticizes Kant's definition of matter through the last categories of this sphere. Its counterpart is appropriately placed after Hegel's own definition of matter with the first category in this sphere. (Return)

19. *EN* (1830), ?254; *Werke*, 9: 42; Miller, *PN*, p. 29. See also *Logik* (*Werke*, 5), pp. 214-15; Miller, *Logic*, p. 189. Besides treating space and time as pure quantities, Hegel also mentions the logical categories of continuous and discrete quantity in the remark on time; *EN* (1830), ?59 Anm.; *Werke*, 9: 52-4; Miller, *PN*, pp. 37-9. (Return)

20. Hegel defines quantum by the indifference and externality of the determinateness and the something that it determines; *Logik* (*Werke*, 5), p. 209; Miller, *Logic*, p. 185. In nature, the something that is determined is the absolute idea. (Return)

21. For example, Hegel speaks of space as a concept that contains differences (*EN* [1830], ¶55; *Werke*, 9: 44; Miller, *PN*, p. 30), but he adds that its difference is qualitative (*EN* [1830], ¶56; *Werke*, 9: 44; Miller, *PN*, p. 31), by which he means that the difference, namely, otherness, belongs to quality, the first large grouping of logical categories. (Return)

22. Though he does not adopt the scheme I propose here, Dieter Wandschneider, *Raum, Zeit, Relativität. Grundbestimmungen der Physik in der Perspektive der Hegelschen Naturphilosophie* (Frankfurt: Vittorio Klostermann, 1982), p. 48, also refers to categories of determinate being, notably limit, to characterize the point. (Return)

23. Michael Foster's article, "The Christian Doctrine of Creation and the Rise of Modern Science," *Mind* (1934): 446-68, remains valuable. (Return)

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