An Informational Interpretation of Monadology[1]

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Abstract

In this paper, I will try to exploit the implication of Leibniz's statement in *Monadology* (1714) that "there is a kind of self-sufficiency which makes them [monads] sources of their own internal actions, or incorporeal automata, as it were" (*Monadology*, sect.18). Leibniz's monads are simple substances, with no shape, no magnitude; but they are supposed to produce the phenomena resulting from their activities, which for us humans look as the whole world, the nature. The activities of a monad are characterized by mental terms, *perceptions* (internal states) and *appetites* (which change the internal state). By means of perceptions, a monad becomes a "perpetual living mirror of the universe"; it can receive the information of other monads and it can send its own, in turn, to others. The communication and interconnection thus produced result in the physical and the psychical phenomena observed by us, humans. According to Leibniz, all monads are governed by the *teleological* law given by the God, and the world of phenomena are governed by the *causal and mechanical* law. Leibniz argues that there is a *pre-established harmony* among the monads so that this double character is no problem.

Now, I will propose an informational interpretation of monadology, which regards the monads as an automaton governed by the God's program and arranged appropriately; and I will argue that Leibniz's scenario can be defended in terms of this interpretation. The crucial part of this interpretation is that the God's program and the monads' activities are related with the phenomenal world by means of a *coding* by God. This interpretation is also defended on the textual basis, with a special reference to Leibniz's distinction between *primitive* and *derivative forces*. Drawing on R. M. Adams's careful reading of Leibniz's texts (*Leibniz: Determinist, Theist, Idealist*, 1994), I will argue that his rendering is quite in conformity with my

[1] I wish to thank Dr. M. Matsuou for reading and commenting on the two earlier versions of this paper. His comments and questioning were greatly helpful to clarifying several obscure points in my interpretation.

interpretation, although he does not seem to be aware of the notion of coding.

1. The Basic Features of Monadology

In this paper, I should like to present an interpretation of Leibniz's monadology in terms of the concepts of the informatics, the theory of information. And this is meant to illustrate a way to utilize our contemporary tools for interpreting a great historical figure of philosophy of science, and to make his valuable insights alive again in our days. Since we are now in China, let me quote from Confucius: "Cherishing the old and thereby deducing something new, you may become a teacher" (*Analects* 2-11). My research was made in the spirit of this saying, but I will venture to add a new phrase, as far as the philosophy of science is concerned, in the conclusion.

It is well known that Leibniz likened a monad to an automaton. In the Section 18 of *Monadology*, he said, "there is a kind of self-sufficiency which makes them [monads] sources of their own internal actions, or incorporeal automata, as it were." I am going to take this statement seriously, and I will claim the word "automata" should be understood roughly in the same sense as our modern sense in the informatics. I will further claim: (1) my interpretation makes easier to unify teleology and causality in Leibniz, and (2) it can clarify the relationship between the monads and the phenomena, in conformity with Leibniz' text; and finally, (3) it can illustrate the informational aspect of Leibniz' philosophy of science. But first let us review the basic features of *Monadology*.

Monads are, according to Leibniz, the ultimate individuals that are supposed to produce all phenomena of our world, physical and mental. They are simple entities with no shape, no magnitude. But they have internal states (called *perceptions*), and the capacity (called *appetite*) to change their internal states. By means of these perceptions, each monad can reflect the states of other monads, and by this interaction, the monads produce the physical and the mental phenomena altogether. It should also be remembered that the monads are organized into groups; in particular, conscious beings, such as animals or humans, have a central monad (called *soul*), and other monads in the group,

roughly speaking, constitute its *body*; the soul somehow acts as a Central Processing Unit (CPU) in the group, and the whole group forms an *organic* body. I understand the "phenomena" are higher order perceptions of some organic body (such as humans), i.e., conscious perceptions produced by a multitude of perceptions (and other activities of monads), as is indicated in the following figure.

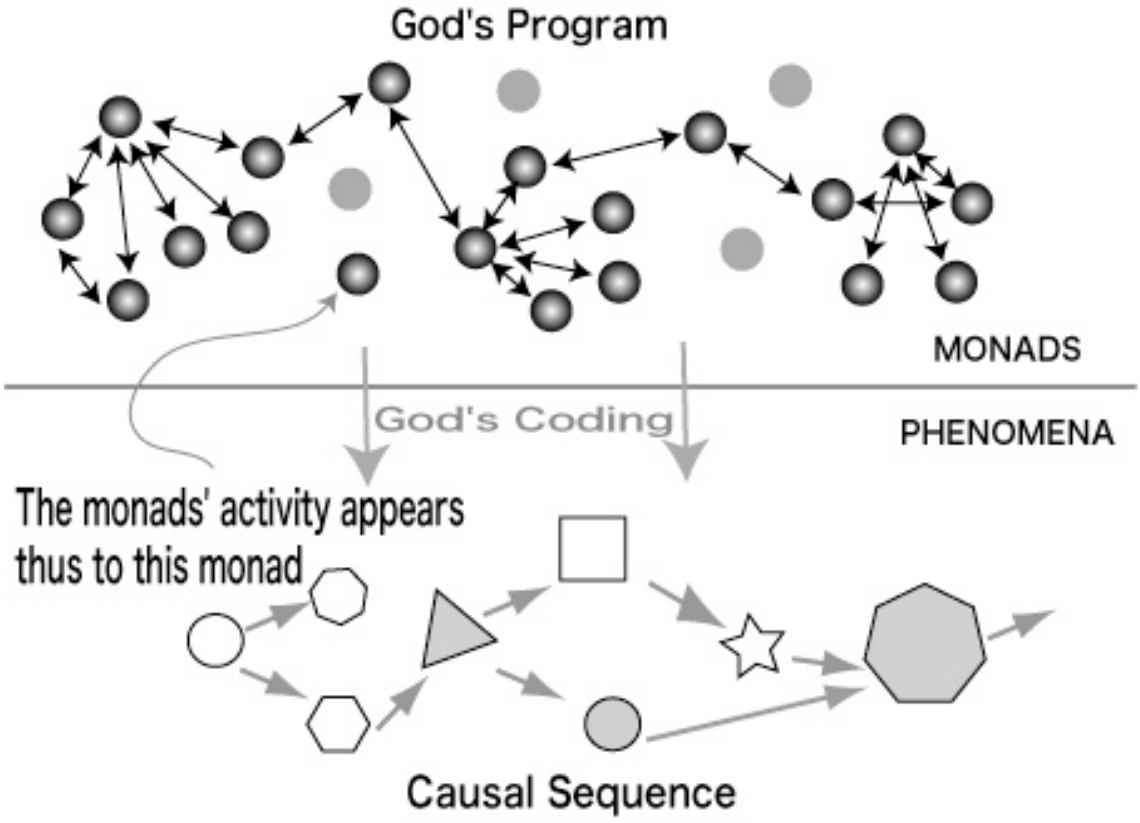

Figure 1 Diagram of Monadology

It may be interesting to see that this idea of "organic body" composed of monads finds a specific example in the 20th century: John von Neumann's cellular automata. Two-dimensional infinite space is filled with the same unit automata (each is a cell automaton), connected with the four neighbors around it, and any finite complex automaton can be constructed in this space (see Figure 2).

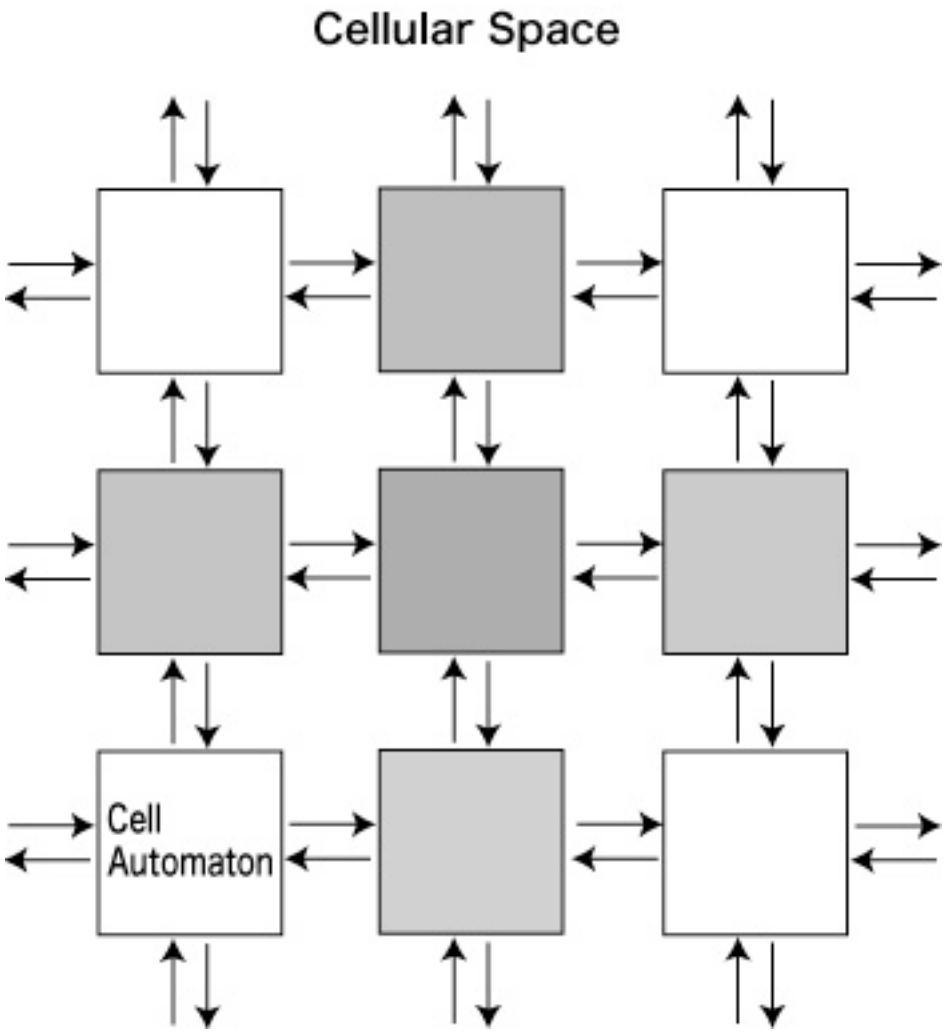

Figure 2 Cellular Space

In particular, a universal Turing machine can be constructed, and, given a tape—again composed of cell automata---with coded information of its own structure, it can reproduce the same machine as itself, within the space (see Figure 3). Each cell is an automaton, but a higher order automaton, including its own CPU composed of a number of cell automata, is constructible. Its basic idea goes back to Leibniz, although von Neumann may have had no direct connection with Leibniz.

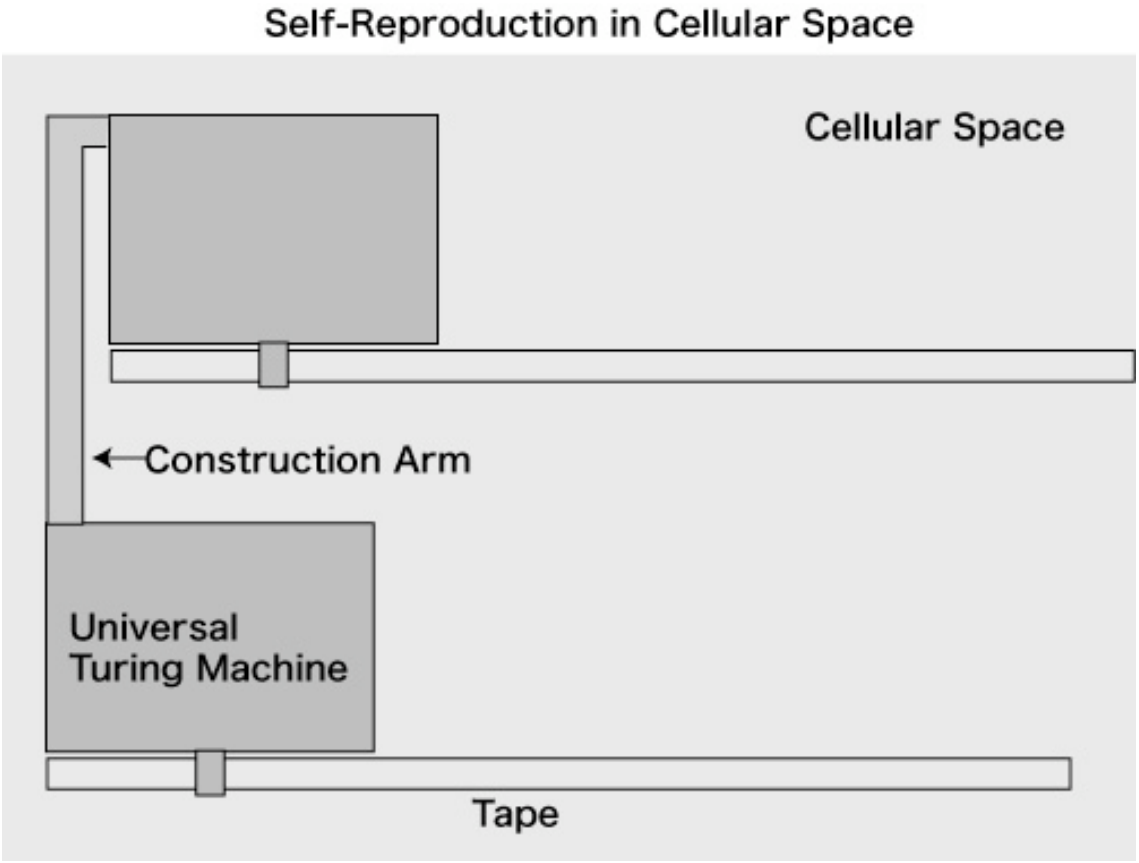

Figure 3 Self-Reproducing Automata

Now, back to monadology. According to Leibniz, the monads are governed by the *teleological* law (final cause) imposed by God, whereas the phenomena (which appear to us, humans) are governed by the *(efficient) causal* law. Leibniz argues that there is no inconsistency between these two aspects, because God created the monads and their phenomena with a Pre-established Harmony; that is, the two aspects fit together nicely according to God's design. But many people may question this claim: "Why, and how is this harmony possible?" One great virtue of my informational interpretation is that we can easily answer this question.

2. Outline of my Informational Interpretation

Leibniz's monads are primarily the bearer of information (what Leibniz called perception), and they are programmed by God to change their internal

states (informational contents). Now, it is clear that God's program is teleological, since His program is meant to fulfill some purpose. Even our programs for computers are teleological, since they are meant to do some job. However, a program must be related with something else, external to the program itself.

Take a program for the Turing machine, for instance; say, a program for computing the successor function. It is clear that this program is teleological, since it has a definite purpose to fulfill. Supposing the tape of the Turing machine has its content in binary code (either a mark or blank), a program is a series of instructions to handle the tape and its content. But in order for this program to do the intended job, we have to establish the correspondence between the configurations on the tape and the numbers (which are independent of the tape or configurations of mark). This correspondence is achieved by means of coding. Thus the program makes sense only in combination with the coding. This is indeed an elementary point the informatics teaches us.

All right. But if we want to build a physical device for the same computation as the Turing machine with this program, what are we going to do? We have to design such a device in conformity with the laws of physics, and the computation of this device must be executed causally, in our actual world. Thus, in a word, the teleological program must be executed causally, in the actual, physical world. In this case, no one would deny the compatibility of teleology and causality. Then, roughly the same holds, for Leibniz's monadology. This is the crux of my Informational Interpretation of monadology. The monads and their perceptions can be handled by informatics, in terms of teleology; but the activities of the monads are supposed to be responsible for the world of phenomena, which we humans take as the world of physical and mental events. The world of phenomena is regulated by causal laws, and God's program must be executed in this world of phenomena. Thus, God has to supply a coding for the correspondence between the activities of monads and the world of phenomena. The phenomena, as I understand, are higher order,

conscious perceptions produced in some organic body; hence the problem is, how to bridge between lower perceptions and higher perceptions.

Here, some complications come in, because, according to Leibniz, the phenomena are produced as a result of the activities of the monads. The phenomena are, so to speak, how the monads' activities appear to the mind of an observer. But I suppose God can choose the way the monads' activities look to an observer, and that is determined by God's coding. Our coding for the Turing machine presupposes two independent entities: there are natural numbers, on the one hand, and configurations on the tape, on the other hand. But Leibniz's God creates the monads, and He determines the coding for the phenomena, how the activities of the monads look to organic bodies with consciousness. Thus God is the system designer of the world of monads, together with the phenomena produced by their activities. God's program is teleological, but the laws of phenomena, determined by the monads' activities and God's coding, are causal and mechanical, which are subject of our scientific knowledge.

Further, we may ask: Can we ever know God's program, or at least a portion of it, and if we can, by what means? I think Leibniz's answer is "Yes", and I would venture to say that he thinks scientific research of phenomena is an indispensable means for that. This was clearly indicated in his correspondence with Christian Wolff, in terms of the relationship between the primitive forces and the derivative forces (for this, I owe a great deal to Robert M. Adams 1994, ch. 13). I will come back to this point later, when I try to clarify the relation between the informational content and Leibniz's notion of forces.

Thus, according to my Informational Interpretation, the whole structure of Leibniz's monadology looks like this: (1) First, from God's side: He creates the monads and programs their activities (teleological law). These activities proceed, and they are projected, so to speak, onto each monad's internal screen; how these activities appear to monads is coded by God, so that the phenomena are produced according to the monads' activities *together with* this coding. The

result is that the phenomena proceed according to the causal law. (2) Second, from our (man's) side: we notice that the phenomena seem to occur according to some regularity, and we try to extract the causal laws underlying the phenomena; this is scientific activity, including the common sense. But if we further wish to know the ultimate law of the phenomena, there still is a higher level of knowledge, i.e., decoding the phenomena and their law. If we are lucky enough, we may know some portion of God's program. This is quite analogous to the physicist's search for the ultimate theory of the world; but Leibniz goes further than this, because he wants to explain the mental phenomena too.

3. Leibniz' Classification of Forces

So far, I have merely presented an outline of my interpretation. Now I have to state the reasons why this interpretation looks good to me. A good clue is Leibniz's classification of forces.

In *A Specimen of Dynamics* (1695), Leibniz classifies the forces into four categories: The primitive force, active and passive, and the derivative force, active and passive. The *primitive active force* is said to be "inherent in all corporeal substance as such, since it is contrary to the nature of things that there should be any body which is wholly at rest"; and also that it is "none other than the first entelechy" and "corresponds to the *soul* or *substantial form*". But by this explanation alone, we cannot figure out what it is. As regards the *derivative active force*, it is said to be "as it were the limitation of primitive force brought about by the collision of bodies with each other". Again, by this explanation alone, it is hard to understand. Similar explanation of passive force (primitive and derivative) follows, but I will skip it. What is important here is that Leibniz is trying to get at the mechanical notion of force applicable in physics, and his specific discussion in this paper is wholly restricted to the derivative force, in such phenomena as motion and collision.

From other sources, we can infer that the primitive force is attributed to the level of substance, and the derivative force to the level of phenomena, including

physics. All the same, the relation between the primitive forces and the derivative forces is quite obscure at this stage.

4. Leibniz's definition of "Action/Passion" in *Monadology*

With this unresolved problem in view, let us now turn to *Monadology*, Leibniz's final form of metaphysics. Surprisingly, in this brief writing, the word "force" never appears. Instead, the interactions between monads are now characterized in terms of perceptual concepts. That is, a monad is *active* vis-à-vis another, in so far as the former has *perfection*; and "perfection" means "perceptions are *distinct*". Passivity (or Passion) is the reverse of this, and a monad is passive in so far as it has confused perceptions. Thus, clearly, Leibniz now takes an informational approach for the characterization of the monads' activities. For, the words "distinct" and "obscure" are primarily concerned with the informational content of a perception: a clear perception in one monad can explain what happens in another monad.

Then, what is the relation between this notion of activity and Leibniz's previous notion of forces? A clear statement is found in Leibniz's correspondence with de Volder, around 1704. Leibniz says that it is obvious that "primitive forces can be nothing but the internal strivings of simple substances, strivings by means of which they pass from perception to perception in accordance with a certain law of their nature" (Ariew and Garber 1989, 181). In short, Leibniz now regards perceptions as basic, and the primitive forces can be reconstructed in terms of the transition of perceptions. This is the main reason why I call Leibniz's approach informational.

5. R. M. Adams' Clarification

Having ascertained the basic stance of Leibniz in *Monadology*, let us come back to the question of the relationship between primitive and derivative force. Robert M. Adams pursued this question, and he has shown, convincingly on my opinion, that the derivative forces have a mixed character, covering both

physical force and intramonadic force. Recall that in *A Specimen of Dynamics* (1695), the derivative forces were placed in the physical world, the world of phenomena. But if derivative force is a *modification of* primitive force that is in a monad (substance), how can it be in the physical world? How are they related? These are the unresolved problems.

Adams' clarification is illuminating. As we have already seen, the primitive force is identified with "the internal strivings of simple substances, strivings by means of which they pass from perception to perception in accordance with a certain law of their nature". The primitive force thus characterized should be understood as a *comprehensive* force *persisting* together with the monad itself. But the "operation" of this force takes place consecutively, one operation at an occasion, another at another occasion, etc. In this way, each operation is restricted to an occasion. Thus each operation of the primitive force should be regarded as the *derivative* force, a *modification* of the primitive force. This is Adams' interpretation. The point is that, while the primitive force is eternal, its modification or derivative force is restricted to each occasion for the operation.

Thus Adams claims that the operation of the primitive force thus characterized is not the present perceptions of a monad, but the present *appetites*, since the operation *connects* the present perceptions to the next perceptions. That is exactly what appetites are supposed to do.

The same point can be more easily seen, in terms of a transition function of an automaton. An automaton changes its internal state according to a transition function; this function is a totality, covering all possible combinations of internal states and inputs. But for its operation, this function needs specific data such as the present state, or the present input; given these, the transition function determines the next internal state. This contrast between the transition function (totality) itself and its operation at a given instant, is quite analogous to the distinction between the primitive force and its operation, derivative force.

Thus, the derivative force as intramonadic force has been clarified. In my own terminology, the derivative force signifies specific operations of a monad's program (given by God); it is synchronized with the operations of all other monads (again by God's programming), so that one may concentrate on the given monad alone, and hence the derivative force as well as the primitive can be regarded as internal; anyway, other monads are reflected in each monad.

But, then, how can we explain the derivative force as physical force? Many bodies physically interact with each other, in such phenomena as collisions, for instance. Thus it seems that an internal state of such a body is clearly insufficient for explaining such phenomena. How is it possible that physical forces such as inertia or kinetic energy of several bodies concur to produce a mechanical phenomenon?

Here, again, Adams' analysis (1994, 383-386) is illuminating. Drawing on the Leibniz-Wolff correspondence during 1710-11, Adams reconstructs Leibniz's answer to Wolff, as regards the role of the primitive force in physical phenomena such as collisions. Leibniz's answer is basically this: even in such physical phenomena as collisions, no force is transmitted from one body to another; each body is moved only by its own derivative force, which is internal to it. How is this possible, according to Leibniz's monadology?

An organic body composed of monads has within itself a *representation* of all the external circumstances that affect it. This means that, if this organic body is to collide with another, its internal representation includes this circumstance, and the correspondence of its motion with the other's is assured by a Pre-established Harmony. Leibniz says, "the Entelechy itself is modified corresponding to these mechanical or derivative forces"; and this means the primitive force is internally modified in a monad, thereby becoming internal derivative forces, and these in turn correspond to the mechanical forces. Thus, derivative physical forces acting in such a collision can be all reduced, in a way, to the derivative forces internal to each monad. This is, in essence, Adams'

rendering. I agree that this is quite in conformity with Leibniz's text.

However, there is still a missing link in this rendering. Physical forces are at the level of phenomena, whereas the primitive force and the internal derivative forces are within each monad. What is it that bridges the two sides? Adams says it is "expression" or "representation". But still, the nature of such "representation" is unspecified. That is why I added a qualifying phrase "in a way", when it is said that "physical forces can be all reduced to the derivative forces". The nature of this "reduction" is not clarified yet, and this is the only complaint I can make of Adams' rendering.

6. Representation via Coding

At last, I can begin to state my own message. As we have already seen, the realm of monads and the realm of phenomena are quite different. The former is reality, the latter mere appearance. In order to connect these two different realms, *coding* is necessary, just as we connect the realm of natural numbers with the realm of possible configurations of marks on a tape. The phenomena, i.e. the appearances of the activities of the monads to some monads, are realized, so to speak, by the "software" of God, God's programming. Then, of course, some coding is presupposed; and only this can achieve the correspondence between the reality and the phenomena; for that correspondence cannot be causality in the usual sense (efficient cause), but a sort of teleological mapping of one realm to another, which is nothing but coding in the general sense.

Thus the concepts of the informatics provide a great deal of help for spelling out the exact nature of the "reduction" or the "correspondence" which Leibniz and Adams were trying to get at. And, as I have argued in the outline of my interpretation (section 2), the notion of coding enables us to see clearly the compatibility of teleology and causality.

7. Science as Decoding

The last question I wish to address is the role of science in monadology: if the reality is coded in the phenomena, what is our scientific activity supposed to do, according to Leibniz's monadology? This problem was also touched upon in the Leibniz-Wolff correspondence during 1710-11. Again, my interpretation heavily depends on Adams' rendering, but I believe mine emphasizes a neglected aspect of monadology.

Let us follow more of the Leibniz-Wolff correspondence during 1710-11, with the help of Adams' rendering. Despite Leibniz's explanation of derivative forces, Wolff could not understand the relationship between intramonadic forces and physical forces. This is quite understandable, because Wolff could not appeal to the help of the concepts of informatics! Pressed by Wolff's request, Leibniz now discloses his opinion as regards the means by which we may know how the primitive force is modified in monads, say, when a heavy body is falling and accelerated. His answer is surprisingly simple: "the modification of the primitive force that is in the Monad itself cannot be explained better than by expounding how the derivative force is changed in the phenomena." That is to say, since the physical force is an expression of the intramonadic derivative force, the best way to detect how the primitive force is modified in the monad is to study the manner of change of the physical force. Although Adams himself quotes this passage as a ground for saying that the physical force and the intramonadic derivative force are *identical* (Adams 1994, 386), I diverge from Adams here.

According to my Informational Interpretation, the physical force and the intramonadic derivative force *cannot* be identical, since they belong to different realms. As I have repeated again and again in this paper, the relation between them is that of coding, i.e., correspondence between two entirely *different* entities. Therefore, even if we agree with Leibniz that the study of physical phenomena is the best way to know *that* the primitive force is modified, the exact manner *how* it is modified is still to be known. How should we proceed to this deeper knowledge? My Informational Interpretation naturally suggests the following: the subject of this deeper knowledge is God's program together

with His coding; and the basic method for attaining such knowledge should be *decoding*, i.e., reconstructing the original message from the coded message. Thus, from physical phenomena, we have to extract regularities (laws), and from these regularities we aim at a unification of them, and then we have to figure out the underlying coding; if we can succeed in this, then we may be able to recover some portion of the original program.

I believe Leibniz's view of science was close to this picture. And the science in the last and this century came closer to this picture. For, the method of informatics became indispensable in many fields of science. For instance, the study of quantum gravity suggests that there is a discrete unit of physical information: continuous mathematics breaks down at the level of Planck length, and the minimal area which can contain one bit of information is known to be 4 square Planck length. Again, in the field of molecular biology, the method of informatics is now a common sense. Thus, whether or not we aim at God's program, an informational approach in science is becoming more and more important.

But this is not my final message. What I wish to emphasize in this conclusion is that applying new concepts to old philosophy may well be fruitful. If my argument in this paper was successful to some extent, you may have realized this already. So, let us go back to the words of Confucius I have quoted in the beginning. "Cherishing the old and thereby deducing something new, you may become a teacher", and I may add, "Interpreting the old in terms of something new, you may revive the old".

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