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THE CONCEPT OF MOTION IN LEIBNIZ' EARLY PHILOSOPHY AND ITS INFLUENCE ON THE DEVELOPMENT OF HIS PHILOSOPHICAL METHOD *

Compared with Leibniz' mature metaphisical system, commonly called the theory of Monads, his early philosophy has been paid relatively little attention to. For similar reasons the study of Kant's pre-critical writings has been temporarily neglected. The great original philosophical systems which Kant and Leibniz published at the age of 57 and 40, respectively, were regarded by both of them as the main achievements of their lives and as their philosophical legitimations; and it is in fact these systems which have deeply influenced the development of human thought. In their eyes and in those of posterity the works that had been written prior to the conception of their final philosophy were only of minor, if any, importance. They were regarded as the products of juvenile and immature minds. Nevertheless, a closer examination of the early thought, especially in the case of Leibniz, is very rewarding. It can open up new ways of understanding his mature philosophy which the latter, if considered in itself, cannot offer. [1]

An approach like this can rely for its justification upon one of Leibniz' basic methodological principles which suggests that if a certain object or a set of objects are to be understood one has to go back to their origin and find out the conditions which led to their generation. [2] This principle proves successful also if applied to the philosophy of

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[1] Among the studies of Leibniz which attempt to show the origin of his mature philosophy in his early writings the most valuable are: Willy Kabitz, *Die Philosophie des jungen Leibniz*, Heidelberg 1909; Martial Gueroult, *Dynamique et Metaphysique Leibniziennes*, Paris 1934; Joseph Moreau, *L'Univers Leibnizien*, Lyon 1956; Friedrich Kaulbach, *Der philosophische Begriff der Bewegung*, Köln-Graz 1965.

[2] Cf. *De Synthesi et Analysi universali seu Arte inveniendi et judicandi*, in: Gerhardt, *Die Philosophischen Schriften von Gottfried Wilhelm Leibniz*, Vol. 7, Hildesheim 1965, p. 292 (below quoted as: Gerhardt).

Leibniz. The examination of certain ideas and problems to be found in his writings as early as 1671 casts a surprisingly new light on the Theory of Monads. It is the ultimate aim of this paper to show one such possibility of understanding Leibniz' later metaphysics by an examination of his early thought. It attempts to give some hints at the systematical and the historical origin of the Theory of Monads. This origin will be found to lie in Leibniz' methodology, *i.e.* in a decisive shift from the purely deductive and mathematical method both in science and in philosophy in his early years to the more inductive and empirical method of his later years. To illustrate this the main part of this paper is dedicated to an examination of Leibniz' treatment of the concept of motion in his early years prior to the conception of the Theory of Monads.

In his discussion of the problem of motion, Leibniz from the very outset (since 1665 or 1666, *i.e.* since the end of his earliest, scholastic period) resolutely abandoned Aristotelianism and adopted the view of the new philosophy of nature of the 16th and 17th centuries, according to which motion is nothing but local motion, *i.e.* change of place or situation. In examining Leibniz' major writings and letters on the philosophy of nature from before 1670 one immediately realizes that from the very beginning he pays particular attention to two problems of motion—that of its nature and that of its origin. Nowadays those problems are considered as part of the theory of the foundations of natural science; for Leibniz, however, they belonged to metaphysics. Therefore we shall have to look upon Leibniz' treatment of motion primarily as a problem of contemporary metaphysics. The term "metaphysics of nature" used in this paper is to be understood in this sense; it is meant to be a philosophical foundation of natural science, notably of physical motion and its laws.

First, let us turn to the problem of the origin of motion. It derives logically from the principle of sufficient reason which can be found *expressis verbis* at various places still before 1670. In the treatise *Confessio Naturae contra Atheistas* (1668) Leibniz expresses it this way: "Omnis enim affectionis Ratio vel ex re ipsa, vel ex aliquo extrinseco deducenda est." [3] Applying this principle to motion Leibniz arrives at the question: Does motion originate from physical bodies or is it conveyed to them from without? In order to answer it he has first to enquire into the nature of physical bodies, *i.e.* he has to look for the definition of a physical body. This definition renders the essence of an object and without it we cannot tell which properties can be deduced from the object and which cannot. Leibniz is quite sure of having the true definition of a physical body. According to this definition the essence of bodies consists in extension (*extensio*) and impenetrability (*impenetra-*

[3] Gerhardt, vol. 4, p. 106.

bilitas, antitypia). Extension is a purely geometrical property. Therefore it is only impenetrability which distinguishes matter from empty-space, the *corpus physicum* from the *corpus mathematicum.* Unfortunately, Leibniz is by no means clear about the nature of impenetrability. The term is not much more than a mere label for a whole set of unknown properties (among them cohesion) and it is not until the 1680's that he finds a solution to the problem of materiality.

Does this definition of physical bodies contain or somehow give rise to motion as a universal property of the physical world? One can, to be sure, deduce magnitude and figure from it (if only as general properties, not as this particular magnitude or this particular figure); but the concept of motion is not contained in the definition, nor can we deduce it in any conceivable way from it. Consequently, motion does not originate in the physical world; it comes from outside, *i.e.* from God. Leibniz explicitly refers to the Aristotelian doctrine of the prime mover.[4] If this world were left to itself, motion would be non-existent; there would be nothing but homogeneous prime matter uniformly distributed throughout space.

Accordingly nature, *i.e.* the physical world, is no independent realm, it has no substantiality as it has in Descartes. For Leibniz a substance is an entity which bears the origin of its activity in itself. All activity of physical bodies consisting in locomotion, a physical body in order to be a substance would have to have the origin of its motions in itself. This is impossible, as it is brought out by its definition. Therefore, physical bodies can be no substances. Only the soul or the mind (*mens*) are substances. Bodies are accidental, they partake in a substantial being only insofar as their movement is continuously sustained by the supreme substance, *i.e.* by God. Let us now consider the second problem. Here, things are getting more difficult. Leibniz thinks he is sure about the origin of motion, but he is by no means sure about its nature. Is motion something real, is it something like an entity? Leibniz apparently answers in the affirmative when, in a long letter to his academic teacher Jacob Thomasius written in 1669 he declares that there are only four kinds of real entities, namely space, matter, motion and spirit.[5] In the same letter, though, he expresses serious doubts whether motion has any reality at all.[6] What seems to him doubtful is, above all, its continuity, its being a permanent impalpable flux not to be fixated in any one moment and at any one place. One thing is, however, quite clear to him. If there should be anything real in motion it would have to be conceived as ultimate parts or elements to which motion finally can be reduced and out of which it could arise as a continuous process extended

[4] For example in a letter to Thomasius, Gerhardt, vol. 1, p. 11.
[5] Gerhardt, vol. 1, p. 24.
[6] Gerhardt, vol. 1, p. 24.

in time and space. For two reasons, the nature of the relation of these elements cannot be that of the quantitative relation of a part to its whole. First, if we conceive a continuous process as consisting of ultimate parts which can be obtained by finite or infinite division, these ultimate parts will still have to be spatially and temporally extended—which is inconsistent with the concept of an ultimate part. Next, it is inconceivable that by joining those ultimate discrete parts together we shall ever be able to produce the transitory and gliding character which is the peculiar feature of motion as a continuous process. In other words, we may become entangled in all the philosophical paradoxes of continuity.

Leibniz had intensely studied the problems of continuity and when, in 1671, he believed to have found their solution he published his first major work on natural science and its foundations, the *Hypothesis Physica Nova*. Its second part, the *Theoria Motus Abstracti*, is dedicated to an analysis of the mathematical concept of motion.[7] The solution of the problem of continuity offered in this treatise is the theory of the "conatus". This term may have been borrowed from Hobbes, whom Leibniz then studied; in any case it is familiar in 17th century mechanics. A conatus is the ultimate inextended element of motion which distinguishes motion from absolute rest and which cannot originate from rest. Consequently, it is also the element of reality in motion by which motion is distinguished from nothingness, *i.e.* absolute rest just as the 1 is distinguished from the 0. The nature of the conatus is defined by Leibniz as a tendency towards motion; not towards motion in general but always towards this particular motion with this particular velocity and this particular direction which it tends to produce. We may say that motion is "concentrated" in the conatus or that it "represents" the conatus, which in itself is inextended, in the mode of spatial and temporal extension.

The conatus of bodies in motion can either be added to or subtracted from one another. In the former case the body will move faster, in the latter it will move slowlier. If two or more conatus with different directions are merged, a new conatus with a new direction will arise. If, however, two conatus are directed perpendicularly to each other, there are two possibilities. Either the stronger conatus conquers the weaker with the effect that the body possessing it continues its motion, if with diminished speed, or the two conatus are equally strong, in which case they compensate each other and their bodies come to a standstill. This does not mean, however, that the conatus have been extinguished. Being ultimate real entities they cannot be destroyed but only be added, substracted or compensated. Let us take, for instance, circular motion.

[7] Gerhardt, vol. 4, p. 224.

Leibniz explains it by two conatus of equal strength being directed perpendicularly to one another; they act upon one another without interruption, thus forcing a body to move in a circle. If one of the conatus loses in power the course of the body in question is still a curve but no longer a circle. If a conatus ceases entirely the body breaks free from the periphery moving either towards the centre or along the tangent of the circle.

Yet, there is something unsatisfying about the conatus. It has no "life of its own" but has to be perpetually preserved from without, *i.e.* by God. It is a metaphysical entity unable to sustain itself beyond the present moment. Leibniz therefore calls a moving body in itself a "momentary spirit" (*mens momentanea*) meaning that it is no independent entity—no substance. This is necessarily so because Leibniz throughout the *Theoria Motus Abstracti* consistently sticks to his definition of physical bodies employed in his earliest writings. According to that definition, as we have already seen, a body in motion will possess three essential qualities: a definite extension and a definite movement (*i.e.* conatus) as well as impenetrability. However, it possesses no inertia, elasticity or kinetic energy. Motion and the laws of motion, Leibniz thinks, are completely explicable from the different kinds of the composition of conatus. Thus, a physical body in motion does not basically differ from a mathematical body. Under these presuppositions the only true theory of motion for Leibniz is abstract kinematics and this is what the *Theoria Motus Abstracti* is mainly concerned with. Its purpose is a purely geometric deduction of all the possible "movements, figures, lines of movement and bodies". It is in fact more than a mere kinematics, it is an attempt at an abstract physics constructed after the model of the Euclidean *Elementa,* an ambitious project which Leibniz expresses in the following way: "Omnes possibles lineas, figuras, corpora et motus secundum omnes lineas Physice construere meris motibus rectis inter se aequalibus, item meris motibus curvis cujuscunque generis, adhibitis corporibus quibuscunque." [8]

This concept of motion which claims to produce something like a physical world by geometric means alone has but little to do with real, *i.e.* empirical motion. A world created after the principles of the *Theoria Motus Abstracti* would look very different from the world as we know it. Leibniz thinks that this kinematically constructible world results inevitably from his presuppositions and is therefore a necessary one. The reason why empirical reality is different is unintelligible at this point of the discussion and will become clear later on. In any case there arises a contradiction between the results of mathematical deduction on the one hand and the data of experience on the other.

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[8] Gerhardt, vol. 4, p. 234.

This contradiction is best illustrated by a comparison of the laws of elastic impact, which Leibniz deduces in the *Theoria Motus Abstracti*, with those discovered by Huygens and Wren. There is some evidence that Leibniz has gone deeply into the laws of the centrally directed elastic impact which Huygens and Wren had published independently in 1669. In this paper we are essentially interested in the first two of these laws. The first may be rendered in this way: If an elastic body in motion collides with another elastic body at rest and of equal magnitude, then the former body will cease to move, the second will obtain a velocity equal to that of the first body before the impact. The second law runs as follows: Two equal bodies move on the same straight line in the same direction, the second body moving faster than the first; after the impact, however, the first and slower body will move with the very speed the second one had before the impact and vice versa, *i.e.* the velocities will have been exchanged.

Leibniz admits that these two laws are valid in the case of the empirical impact, but he denies their validity in the case of the impact in the purely kinematical sense. According to his abstract kinematics, in the case of the first of the two laws, the body at rest would offer no resistance at all to the body in motion impinging on it, *i.e.* the latter body would continue its course in the same direction with undiminished speed. There would be no longer two but only one body after the impact. For similar reasons Leibniz also rejects the second law of Huygens.

The exchange of velocities between the two bodies as it is stipulated by the law of Huygens and as it is confirmed by experience itself is impossible in the *Theoria Motus Abstracti*. According to it the two bodies will not move away from one another after the collision but, on the contrary, will form a single body moving at the original speed of the faster body. According to Leibniz we can regard motion in two ways: from the point of view of pure reason on the one hand, and from sense experience on the other. Should there arise any contradiction between the results of those two approaches, the rational point of view will necessarily prevail. In presenting the true theory of motion we have to ignore completely the point of view of experience. The *Theoria Motus Abstracti* has to be understood in the light of the exigences of pure reason. Sensuous experience is here regarded as a subordinate and unreliable mode of knowledge which obscures and falsifies rather than reveals the true nature of motion. Experience and the results of Leibniz' metaphysico-mathematical presuppositions do not harmonize but contradict each other, a discrepancy which the theory of abstract motion can neither even up nor gloss over.

How can we account for this striking contradiction between abstract and concrete motion, between the kinematical laws of impact and the empirical laws of impact? The reason is of both logical and metaphysi-

cal nature. According to the principle of sufficient reason, as it was expressed in the *Confessio,* nothing may be attributed to the essence of physical bodies which is not contained in their definition. This definition consists of two qualities: extension and impenetrability. The third quality, movement, is produced by God, *i.e.* it is of supernatural origin. Now a physical body which is defined in this way and which is supposed to be in motion can by no means have those qualities which we consider (and so did Leibniz) to be essential to all empirical bodies, namely inertia, elasticity, and kinetic energy (or what he called „living force", *vis viva*), three qualities without which the empirical laws of impact are unintelligible. Now, under these conditions, *i.e.* presupposing his purely kinematical definition of bodies, Leibniz could not arrive at the empirical laws of motion, but had necessarily to end up with the laws presented in the *Theoria Motus Abstracti,* which, as we have seen, flatly contradict experience.

To account for this contradiction Leibniz has to draw a distinction between abstract or rational and concrete or empirical motion. What makes him prefer abstract motion as the "true" motion to concrete motion as the "apparent" one is what we may call his unlimited rationalism, and what makes him arrive at those "rational" laws of motion instead of the empirical laws of motion is the deductive method derived from his rationalist presuppositions as opposed to the empirical or scientific method employed by Huygens.

It should be quite clear from the previous discussion that any world established according to the abstract laws of motion would be a mere chaos. If there were no inertia, perpetual motion would be the result; if there were no elasticity and no kinetic energy, all motion would gradually cease, *i.e.* there would be no world, no matter organized according to certain laws and principles. Nature left to itself would be ruled by a blind mathematical necessity, *i.e.* it would not be governed by reason, but by destructive absurdity. Quite different from that, however, it is an organized system keeping up its order by certain intelligible laws. To prevent the *Theoria Motus Abstracti* from becoming an empty abstract speculation Leibniz feels that he is bound to prove that, in spite of an initial discrepancy, it is a valid theory in the long run, *i.e.* that it is confirmed by experience. He has somehow to bridge the gap between pure reason and sensuous experience. This he attempts in the first part of the *Hypothesis Physica Nova,* the *Theoria Motus Concreti.* [9] Tre purpose of that paper is in Leibniz' own words "omnes motus sensibiles explicare".

Now, still employing the deductive method Leibniz cannot derive the empirical laws of motion directly from the presuppositions of the

[9] Gerhardt, vol. 4, p. 181.

Theoria Motus Abstracti. Therefore, an additional assumption or principle is required which can account for concrete motion. This additional assumption may be called the principle of rational order or, as it will be called later on by Leibniz, the principle of perfection.

A world ruled by the blind geometrical necessity of the composition of conatus, Leibniz argues, is not in accord with the wisdom of God. God would not have created disorder but the best order imaginable. Further on he would not have created a world the order of which has to be preserved by his continuous interference. The world created by him is so perfect as to sustain its order independently. For these two reasons motion has to follow the empirical laws discovered by Huygens, which means that all physical bodies possess inertia, elasticity, and energy.

There are thus two reasons why the abstract laws of motion cannot be valid for the real world: experience which falsifies them and the principle of order which gives an explanation for this. Now the sole principle of order can only be the starting point for the deduction of the empirical laws of motion. In itself it is insufficient for the deduction proper.

What is required is a physical explanation which on the one hand confirms Leibniz' concept of physical bodies but, on the other, explains why physical bodies nevertheless have inertia, elasticity, and energy.

Leibniz attempts to meet these requirements in the *Theoria Motus Concreti* with the hypothesis of the ether penetrating every particle of matter. From the various degrees of penetration he hopes to explain all natural phenomena and, among them, inertia, elasticity, and energy.

He explains elasticity by the circulation of the ether penetrating the bodies according to their density. If two bodies moving in the same direction along the same line with different velocities collide and exchange their velocities (as it is laid down in the second law of Huygens) nothing has actually happened to the body itself: only the ether pervading it has been transferred to the other body and *vice versa.*

Inertia is explained by the fact that bodies in reality are discontinuous. They consist of small particles which, owing to an inner movement brought about by the ether, are pressed against each other for the body to be coherent. They will offer resistance then to a body in motion impinging on them, that is to say, they will oppose their own conatus (apart from which there is nothing real in the bodies) whereby a conatus of equal strength of the impinging body is compensated. The larger the number of the particles of a resisting body the greater the subtraction of the conatus of the impinging body. It is in this way, then, that a body offers more or less resistance to the modification of its state.

By this time Leibniz has not yet got acquainted with the concept of energy or of active force as a dynamic category and the principle of its preservation. What he acknowledges is that bodies in motion can

exert effects and that the sum total of these effects which, following Descartes, he calls "quantity of motion" (*quantitas motus*) obviously remains constant in a self-contained system. He assumes these effects to be proportional to the simple velocities.

According to the *Theoria Motus Concreti,* the sum total of motions in the world should be constantly diminishing, for the concept of conatus does not explain how a body can obtain a velocity which is greater than its own before the impact from another slower body. And this necessarily is the case when the sum total of motion before and after the impact remains constant as it is laid down in the second law of impact by Huygens. Besides each curvilinear motion (with a curved course) would——owing to reasons we have pointed out already—turn into a rectilinear motion so that in the end a state of all bodies moving in the same direction with the same homogeneous velocity would be reached; and this would mean the end of all observable motion. The world, according to this theory, would gradually make for a state of absolute rest; this is a conclusion which, owing to the metaphysical und theological consequences it entails would be point-blank scandalous; the more so when we consider how vehemently Leibniz will later on argue on this point against Newton. Moreover, this theory contradicts the principle of the preservation of the quantity of motion in the world established by Descartes and generally acknowledged. It is therefore incompatible with the *communis opinio.* Therefore, in the *Theoria Motus Concreti,* Leibniz attempts to explain the stability of the sum total of effects by means of the ether perpetually flowing at the same velocity. Only after a thorough examination of his position does Leibniz, some time later, conceive the idea of the capability of bodies to produce future effects and, with that, the introduction of the concept of energy into matter. Only then, together with the concept of energy, he finds the right measure of preservation.

Leibniz tries at first to interpret positively the fact that the world of experience is in itself not explicable from the presuppositions of the *Theoria Motus Abstracti, i.e.* the concept of physical body and of mathematical motion alone. This is the proof, he argues, that reality has neither existed eternally nor been brought forth accidentally, but that an ultimate and perfect being has brought about the creation of the world. Thus, in the *Theoria Motus Concreti* he persistently emphasizes the wise and perfect order of things and, in the prefatory note to the *Theoria Motus Abstracti* he calls it the most distinguished purpose of this work to demonstrate the "intrinsic nature of Thought, the immortality of the spiritual being and the supreme cause by apodictic proofs".[10] Considerations of such kind or analogous reflections could not, in the long run,

[10] Gerhardt, vol. 4, p. 225.

blind Leibniz to the decisive weakness of the system of the *Hypothesis Physica Nova,* a weakness which consists in the insufficiency of its philosophical foundations to deduce physical reality in its most important qualities. This is most obvious in that elasticity, inertia and preservation of motion (*i.e.* energy) are degraded into mere appearance without reality. By a trick of God they are brought into the world where, to human experience endeavouring to explain the phenomena of reality, they counterfeit qualities of bodies which these do not possess at all. Leibniz has to introduce an additional theological assumption in order to uphold his abstract theory against the evidence of experience. The principal criticism of the later Leibniz is levelled against this issue of his early system, and it is exactly there that we find the decisive turning-point in his metaphysics of nature. If empirical motion and its laws were not deducible from the philosophic foundations of the world of bodies as he at that time conceived them, but were explicable only by artificial additional hypotheses, then these very foundations had to be revised, a conclusion which became more and more obvious to Leibniz. The metaphysical foundations of nature had to contain the sufficient conditions for the deduction of the world of experience and its order. The theory of abstract motion had disregarded experience; consequently, to come back to our example, the laws of elastic impact could not be deduced from it. To put it in the words of Cassirer, "experience and reason", *i.e.* experience and rationalist metaphysics, "have not yet been brought into accord". [11]

The problem Leibniz found himself having to face then was a re-examination of the philosophical concept of bodies; a re-examination which had to take into account the results obtained by the discussion of the laws of elastic impact. Thus, a threefold task arose for Leibniz.

First of all he had to abandon the principle obstinately maintained throughout the *Theoria Motus Abstracti* that motion originates outside the physical world. All he had actually to do was to bring out certain implications of the concept of the conatus which his metaphysical assumptions had prevented him from drawing. As we have seen previously, the conatus is supposed to be the ultimate element of motion and at the same time its ontological legitimation, *i.e.* what is real in motion is the conatus and nothing else. Although it is dependent on God's concourse for its preservation beyond the infinitesimal moment of time it is an entity evidently not of the same nature as matter or space but something spiritual. Now, let us suppose that the conatus gets rid of its dependency upon God's concourse; let us suppose further that it is not the infinitesimal element of actual motion but the source of

[11] Ernst Cassirer, *Leibniz' System in seinen wissenschaftlichen Grundlagen,* Darmstadt 1962, p. 502.

motion, a lasting active potency which produces actual motion if not prevented. In this case the origin of motion would lie in physical bodies themselves. Bodies then would contain what Leibniz calls an active, self-suficient and self-sustained tendency towards motion; in short: they would contain force. The essence of bodies, then, would no longer consist of extension and impenetrability alone, but first and foremost of force.

This is a simplified version of the reasoning by which Leibniz was led to a new concept of physical bodies. All bodies are endowed with an active force or *vis activa*. There is no need any longer for God to produce and sustain motion constantly. Nature is a realm ruled by certain laws which it observes independently from any influence or concourse from without. Active force in this sense is, of course, a metaphysical entity but it is the foundation of physical phenomena because it gives rise to what Leibniz calls "living force" (*vis viva*) and what nowadays is called kinetic energy.

The concept of force as the essence of physical bodies offers a satisfactory solution to the second crucial point, namely to the nature of elasticity. If there is in physical bodies a spontaneous active tendency or *potentia* then it becomes intelligible why a body after colliding with another body reacts in turn upon the latter, thus producing the phenomenon of elasticity.

Finally, the problem of inertia receives its solution by an extension of the concept of force. If we acknowledge inertia as a constitutive property of physical bodies—as we are bound to do, if we want to account for the empirical laws of motion—then we have to look for a principle that explains why physical bodies offer a certain amount of resistance to any kind of change of their present condition. Mass or inertia, as Leibniz calls it taking up a term used by Kepler, comes in in both laws of impact which we have discussed in this paper; without it those laws are unintelligible.

The importance of the problem of inertia for the philosophical development of Leibniz cannot be overestimated. As he tells us repeatedly in his later years he was for a long time unable to give a satisfactory explanation of the fact that in the phenomena of motion and impact velocity evidently depended on a certain factor the nature of which was unknown to him. "Nam dicere materiam motui resistere et totum ex *A* et *B* compositum nunc tardius moveri quam antea solum *A*, est aliquid asserere quod ex simplici natura corporis et motus,... si in ea nihil aliud quam spatii impletionem et mutationem intelligimus, duci non potest." [12] Again, as in the cases of energy and elasticity, Leibniz assumes a metaphysical principle underlying inertia which he calls "passive force" (*vis passiva*). Strictly speaking, force as the essence of bodies has

[12] Gerhardt, vol. 7, p. 281.

two different aspects; it is active as the source of motion and kinetic energy and passive as the source of mass or inertia. The active and passive forces together form what Leibniz calls a substance or, from about 1695 onwards, a "monad". Monads are metaphysical entities capable of producing motion and inertia.

This re-examination of the concept of bodies required a re-examination of both his scientific and metaphysical methods. Purely deductive and mathematical physics as it was presented in the *Theoria Motus Abstracti* had been refuted by experience. Science has to explain the phenomena of experience. Obviously the theory of abstract motion does not meet this requirement. Consequently science has to revise its method, *i.e.* its procedure has, at least in part, to be empirical and inductive. The same applies *mutatis mutandis* to metaphysics. The object of the metaphysics of nature, as Leibniz understood it, is the philosophical foundation of natural science. Now, if science is legitimate only as a theory concerned with the actual phenomena of nature, metaphysics is legitimate only as a theory concerned with the philosophical foundations of empirical science. It has therefore also to revise its method.

Leibniz' new metaphysics of nature conceived in the years between 1671 and 1685 and first laid down in the *Discours de Métaphysique* and in the letters to Arnauld in 1686 has an empirical foundation, though not exclusively. The method employed in its formation resembles that of natural science, *i.e.* it is empirical and inductive, at least in part. In subscribing to a maxim consistently maintained also by Whitehead, namely that metaphysics has to explain what is contained in experience, Leibniz tacitly adopts the fundamental principle of the new science of the 16th and 17th centuries represented by the names of Bacon, Kepler, Gelileo, Boyle and Huygens. His new metaphysics of nature may even be called an hypothesis, and that for the following reasons:

(*1*) According to Leibniz the task of a sound hypothesis must not be arbitrary fiction (a sense of the word employed by Newton in his proud dictum "hypotheses non fingo") but a consistent explanation of natural phenomena.

(*2*) For Leibniz the procedure of an hypothesis has to be both inductive and deductive; its validity is to be confirmed in two ways, by descending from the principles to phenomena and by ascending again from phenomena to the principles. This is one of the fundamental rules of Leibniz' theory of science.

(*3*) Finally, Leibniz demands that a sound hypothesis should be simple, clear and concise. The number of basic principles, assumptions or axioms should be as small as possible, but they should enable us to solve as many particular problems, *i.e.* phenomena, as possible. [13]

[13] For Leibniz' concept of hypothesis see his letter to Fabri, Gerhardt, vol. 4, p. 247, also his letter to Conring, Gerhardt, vol. 1, pp. 173—4.

Metaphysics of nature intends to analyse and explain the data of experience by following the principle of sufficient reason. Metaphysics, therefore, has to establish the ultimate and most general foundations of experience. Whereas a scientific hypothesis reduces the particular phenomena to general ones—in the case of the *Theoria Motus Concreti* to the rotations of sun and earth and the ether—metaphysics probes beneath the fundamental concepts of science to discover its ultimate principles.

Such principles appear to be the true foundations of nature only after having been verified in the two ways of analysis and synthesis as described above. Metaphysics of nature, furthermore, must be clear and simple. Here it becomes obvious that the *a priori* proposition of world order is one of the premises of scientific as well as of metaphysical hypotheses. The Theory of Monads as the new metaphysics of nature derives from the inextricable connection of metaphysics and experience, a connection which can be traced back to the influence of scientific hypothesis. This influence is evident from the fact that Leibniz later on repeatedly calls the Theory of Monads as well as the Pre-established Harmony „hypotheses". [14]

Our conclusions ought to be confirmed by a close examination of one of the major documents of Leibniz' mature metaphysics, namely the correspondence with the Dutch philosopher, scientist and mathematician Burcher de Volder. In the letters to de Volder the concept of a primitive active and passive force underlying the phenomena of motion and inertia and inherent in all physical bodies, *i.e.* the concept of the monad, emerges as a metaphysical hypothesis which Leibniz believes to be the only possible satisfactory explanation of phenomena. We cannot here discuss this correspondence in any detail, however interesting for our subject it may be. Only a very brief account of Leibniz' main argument can be given. De Volder is willing to accept Leibniz' concept of monad only on condition that Leibniz gives what de Volder calls an "*a priori* proof". By this he clearly means a deduction which proceeds in the same way as we can deduce from the concept of triangle that the sum total of its angles is equal to 180°. Leibniz persistently refuses to give that deduction by pointing to the fact that "everything must be deduced from phenomena", *i.e.* that the basic concepts of metaphysics must be formed with constant reference to experience.

That Leibniz' famous metaphysical system—the Theory of Monads derives, at least in part, from his philosophy of dynamics has been repeatedly stressed by famous scholars such as Hannequin, Cassirer, Gueroult and others. But there seems to be little appreciation of the fact

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[14] See Leibniz' letter to de Volder, Gerhardt, vol. 2, p. 241; his letter to Lady Masham, Gerhardt, vol. 3, p. 352; the *Système Nouveau*, Gerhardt, vol. 4, p. 485.
[15] Cf. to de Volder, Gerhardt, vol. 2, p. 275.

that it was a problem of method which made Leibniz abandon his early metaphysics of nature. He is still widely believed to be an arch-rationalist who started from pre-conceived *a priori* assumptions and who mainly indulged in lofty speculations about the nature of God, of the soul and of reality in general. This commonplace characterization, if there is any truth in it, may be true of the unlimited apriorism of his early philosophy but tends to overlook the strong current of scientific empiricism in his later metaphysics.