

CHAPTER 3

LEIBNIZ: FORCE AS THE ESSENCE OF SUBSTANCE

The creation of modern dynamics was a matter, not of experimentation and new discovery, but of drawing consequences from accepted conclusions, of clarifying ambiguities and resolving conceptual tangles, above all of breaking through the rigidity of received intuitive conceptions of dynamic action.

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3.1 INTRODUCTION

3.1.1 *Leibniz's Influence on the Eighteenth Century*

Everyone who addresses the controversy surrounding the concept of living force discusses Gottfried Wilhelm Leibniz, or rather, his legacy. In fact we owe both the definition of the term and the beginning of the controversy to Leibniz.² One might consider a less emphatic view of his importance, if one took only the superficial and one-sided transmission of Leibniz's philosophy in the eighteenth century into account. Many of the physicists from that period, even those who were sympathetic to his ideas, had a caricatured picture of Leibniz's system.

For example, Nicolas Béguelin was a natural scientist of some importance at the Berlin Academy. In two essays dating from 1766 and 1769, Béguelin tried to combine Leibniz's metaphysics with Newton's physics.³ In the first of these he interpreted gravitation as a low-level form of a universal tendency to associate with equals ("similis simili gaudet"), with the level being determined by the clarity of the "sentiment," i.e., by the degree of spirituality of the being. The most material being

[1] Westfall, *Force in Newton's Physics. The Science of Dynamics in the Seventeenth Century* (1971), 289. Westfall presents this proposition in the course of identifying Leibniz's primary significance for the development of classical mechanics.

[2] In Leibniz, "Specimen dynamicum pro admirandis naturae legibus (...)" (1695) and "Brevis demonstratio erroris mirabilis Cartesii (...)" (1686), respectively.

[3] Béguelin, "Essai d'une conciliation de la métaphysique de Leibnitz avec la physique de Newton" (1766) and "Conciliation des idées de Newton et de Leibnitz sur l'espace et le vuide" (1769).

seeks a general and indiscriminate association and “embraces all classes of beings.”⁴ The inclination of the most spiritual being, in contrast, is limited to a very exceptional class. Thus, twenty years before the French Revolution, Leibniz dons the uniform of a footman to the aristocrats, although he always argued against the existence of ‘attractive tendencies’!

One of the first competition questions set by the Berlin Academy, the question for 1747, concerned Leibnizian monadology. The way in which it was answered again revealed a stark contrast between Leibniz’s philosophy and its transmission.⁵ D’Alembert, Euler and Maupertuis, likewise, had only a superficial picture of Leibniz, as we will see in Chapters 4 and 5.

This superficial transmission can in part be attributed to Leibniz’s working method. Because he was mainly responding to other people’s opinions, he wrote little that could be published independently. Another reason, of at least equal importance, is the gradual shift in his interest from the synthesis of mechanics and metaphysics to pure metaphysics and natural theology, resulting in the *Essais de théodicée* (1710), the famous correspondence with Samuel Clarke (1717), and the shorter popularising works *Principes de la nature et de la grâce, fondés en raison* (1718) and *La Monadologie* (1720). This shift may also be the reason why it was at first mainly theologians who concerned themselves with editing of Leibniz’s work. The first collections of Leibniz’s writings therefore focus on the portion of his work that is not immediately relevant to physics. One example is the *Des Freyherrn von Leibnitz kleinere philosophische Schriften*, published by C.-J. Huth in 1740. This contains the *Monadologie*, the defense of his idea of the pre-established harmony against the criticisms of Pierre Bayle, his correspondence with Clarke, and a number of pieces composed by the publisher.⁶

Despite enthusiastic attempts, it was a long time before a collected edition appeared containing both his unpublished manuscripts and correspondence and the articles that had been published separately and were difficult to obtain. In 1731 the Leibniz populariser Carl Gunther Ludovici attempted to republish all of Leibniz’s published articles, but the plan was torpedoed by opposition from Elector Friedrich-August von Sachsen.⁷ Most subsequent attempts at a more comprehensive and systematic edition also failed, with the exception of a few fragmentary editions of correspondence.⁸ Diderot was quite right when, in 1765, he accused Germany of still

[4] “embrassera toutes les classes d’Etres” (Béguelin, “Essai d’une conciliation,” 375).

[5] Harnack, *Geschichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin I* (1900), 402-403; Bongie, [Introduction to Condillac’s *Les Monades* (1747)] (1980), 21-35; Buschmann, “Der Monadenstreit um ‘ein Prämium von 50 Ducaten’ ” (1987), “‘Die elendste Schrift, die je gekrönt worden’ ” (1988), and “Die philosophischen Preisfragen und Preisschriften der Berliner Akademie der Wissenschaften im 18. Jahrhundert.” (1989), 182-186.

[6] C.J. Huth ed., *Des Freyherrn von Leibnitz kleinere philosophische Schriften*. (Revision and extension of Köhler’s 1720 translation of Leibniz’s *Monadologie*). Ravier 412. Jena: Mayerischen Buchhandlung 1740.

[7] Ravier, *Bibliographie des œuvres de Leibniz* (1937), 165.

[8] See Aiton, *Leibniz: A Biography* (1985), 351-352.

not having published what had flowed from the pen of this man, who alone brought Germany as much fame as Plato, Aristotle and Archimedes together brought to Greece.⁹ The difficulty of obtaining Leibniz's own work was only partially compensated by the perpetuation of his thinking in the philosophy of Christian Wolff. Wolff, who in the middle of the eighteenth century won great respect for German speculative philosophy and so created the necessary conditions for the development of comprehensive systems such as those of Hegel and Schelling, derived his own philosophical system largely from Leibniz. While Leibniz was extensively popularized as a result—Wolff's system was declared to be the official 'School philosophy' in Germany—this popularization was coupled with simplification and materialization.¹⁰

Finally, in 1768, Louis Dutens brought out the first real collected edition. It was not complete, because Dutens was refused access to the archives of the library of Hanover!¹¹ Because of this refusal, most of Leibniz's unpublished work and correspondence did not become generally available for evaluation until much later. The edition published by Dutens would remain the standard work until C.I. Gerhardt's very extensive edition in the second half of the nineteenth century.¹²

The superficial and faulty reception of Leibniz in the eighteenth century cannot alter the fact that his contribution to and criticism of mechanics has been historically important. Especially in the last two decades of the seventeenth century, the period in which his metaphysical system developed, Leibniz was closely involved in developments in mechanics. In those years, the development of his metaphysical system was closely linked to his attempt to provide foundations for mechanics. At that time metaphysics and mechanics for Leibniz were still equal, in contrast to the situation

[9] Diderot, "Léibnitzianisme, ou Philosophie de Léibnitz" (1765), 379.

[10] Until recently, Wolff's philosophy was regarded as a systematization and faithful elaboration of Leibniz's philosophy, as shown by references to the 'Leibniz-Wolffian School', a term which was in use even during Wolff's life. In recent decades more emphasis has been placed on the fundamental differences between the two. See Heinekamp ed., *Beiträge zur Wirkungs- und Rezeptionsgeschichte von Gottfried Wilhelm Leibniz* (1986), especially Jean École, "Des rapports de Wolff avec Leibniz dans le domaine de la métaphysique," and Hans-Jürgen Engfer, "Teleology und Kausalität bei Leibniz und Wolff; Die Umkehr der Begründungspflicht." This distinction between Leibniz and Wolff also has implications for the study of Leibniz himself, for instance by enabling the relationship between Leibniz's dynamics and metaphysics to be considered anew. Although views of Leibniz have been immeasurably broadened by Gerhardt's publication of the sources (see below, in the text), disproportionate emphasis has continued to be given to his later documents and correspondence. This disproportionate emphasis could be an important factor in the one-sided interpretation of Leibniz's philosophy as a metaphysical and logical system (Daniel Garber, "Leibniz and the Foundation of Physics: The Middle Years" (1986), 27). In fact, it is in the later period of his thinking that Leibniz focuses mainly on the question of individual substance, and that the relationship of the concept of substance with the phenomenal reality of space and time becomes problematical.

[11] Ravier, *Bibliographie*, 176.

[12] In this book I refer mainly to Gerhardt's editions, referred to respectively as 'Gerh. Math. Schr.' (for *Leibnizens mathematische Schriften*) and 'Gerh. Phil. Schr.' (for *Die philosophische Schriften von G. W. Leibniz*).

after about the turn of the century. For example, the reality of matter was not yet in dispute; only the need for a metaphysical foundation for matter was being discussed. With perhaps a little exaggeration, one could say that Leibniz still saw matter at this time as an *abstraction*, whereas later it came to have the character of an *illusion*.

3.1.2 *Leibniz's Significance for Mechanics*

What then was Leibniz's significance for mechanics? Like Newton, but in a completely different way, Leibniz conceives of forces in mechanics within a metaphysics of substance, and assumes on that basis that force is a unity. Newton initially tried to mathematize all *external* forces ("vires impressae"), as external impact forces or as their derivatives, and thus also to explain continuously acting forces on the basis of instantaneously acting forces. Leibniz, in contrast, focuses on the *internal* force, which is the cause of the continuation of the motion of the body, and posits the conservation of force as a general principle for the determination of the laws of motion. The approaches of Newton and Leibniz, like the internal and external forces, can be regarded as complementary. While Newton mathematizes the continuously acting impressed forces, by reducing them to instantaneously acting forces, Leibniz tries to find a mathematical expression for the force of a body in motion, which he at first called the 'moving' and later the 'living' force. In his case, however, the old idea of the unity of cause and effect is much more evident than with Newton; in fact for him it has become a principle, as I will show in the following sections.

In addition to this complementary conceptualization of the concept of force, Leibniz's mechanics contributed an important conceptual clarification that resulted from his idiosyncratic philosophy. He opposed the definition of the essence of matter as extension in space, because it is impossible to explain the laws of motion on this basis. For his own explanation he goes back to the Aristotelian-scholastic metaphysics of substance, which he had learnt to know in his youth.¹³ He thinks he is able to solve the problems that he observes in mechanical philosophy by means of a differentiation of the original homogenous reality into a metaphysical and a phenomenal level. In this differentiation the concept of force plays a connecting role

[13] At the end of the seventeenth century and the beginning of the eighteenth it was not unusual to make a connection between mechanical philosophy and Aristotelian-scholastic metaphysics, but it was generally made by Aristotelian Jesuits who included mechanical philosophy in their physics only as a *hypothesis*, or even as an *instrument*. Heilbron writes that the Jesuits initially entirely rejected Descartes's teachings but later gradually assimilated his physics. The 15th congregation of 1706 permitted the defense of Descartes's physics as a *hypothesis*. One famous Cartesian Jesuit was Ignace Gaston Pardies (Heilbron, *Electricity in the 17th and 18th Centuries* (1979), 36-37). However, Leibniz, who had grown up with Aristotelian ideas but was converted in his youth to mechanical philosophy, develops his thought in a very different way to the Jesuits because he did not assimilate mechanical philosophy but rather *returned* to Aristotelian-scholastic metaphysics in order to be able to provide foundations for mechanics.

because, on the one hand, it constitutes the substances, and, on the other hand, it is the cause of material, phenomenal motion.

3.1.3 *The Structure of this Chapter*

I do not in any way pretend to summarize Leibniz's system in its entirety here. His theology, his moral philosophy and his logic, for example, are entirely beyond the scope of my theme, which is the contribution of his metaphysical system to the foundations of mechanics. In broad terms the remainder of this chapter follows two interrelated themes.

The first theme asks how Leibniz, implicitly, based his mechanical concept of force, on the phenomenal level, on a concept of transference. An important subsidiary question is how Leibniz related the existence of the mechanical action of force to his metaphysical idea that substances can not act on one another, but only on themselves. The second theme follows his attempt to seek the connection between the metaphysical and the phenomenal level in the concept of force.

My argument will proceed first from mechanics to metaphysics, and then return. The starting point is in 1686, when Leibniz introduced the theme of force in a critique of the Cartesian definition of the moving force ("*vis motrix*").¹⁴ Force is here a concept that must be hypothesized as a fundamental of mechanics *in addition to* the concept of extension, in order to be able to explain the laws of motion. Around 1695, the year in which his mechanics and metaphysics were most closely related, Leibniz extended the scope of the concept of force.¹⁵ From then on, force is also the foundation of substance. The concept of force then assumes a complicated structure, with fundamental and derivative forces, each of which exists in both passive and active forms. What Leibniz referred to in 1686 simply as 'force' is now called 'derivative active force'. The question then is, what problems this structure produces for the foundation of mechanics, and in particular for the concept of mechanical force.

[14] Leibniz, "Brevis demonstratio" and the posthumously published "Discours de métaphysique" (both from 1686). Leibniz's earlier eclectic views, in which he still accepted the tradition dogmatically, are less important here. Loemker draws the demarcation line between his early and mature periods in 1690, because only then were the fundamental concepts of individuality, grades of substance, force, and the monad introduced (Loemker, [Commentary on *Philosophical Papers and Letters of Leibniz*] (1956), 355). Although I agree with Loemker as regards the formation of Leibniz's system as a whole, the "Brevis demonstratio" and the "Discours de métaphysique," both written in 1686 although the latter was only published in 1846, cannot be excluded from this study because of their significance for the inception of the *vis viva* controversy and for a number of later problems relevant to the relationship between metaphysics and dynamics.

[15] Leibniz, "Specimen dynamicum" and "Système nouveau de la nature et de la communication des substances (...)" (both from 1695).

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