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The Relationship Between Necessity and Freedom in Spinoza Reevaluated in the Light of Chaos Theory

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Abstract

The relationship between human freedom and necessity remains a central problem in Spinoza's philosophy, particularly in relation to knowledge, cognition, and ethical transformation. This article argues that, just as God/Nature in Spinoza is free insofar as it acts by the necessity of its own essence, so too the human being—though encompassed by necessity—becomes free through the ascent along the degrees of knowledge and the mind's integrative harmony, a process clarified by the dynamics of nonlinear systems. It calls for a reconsideration of freedom, cognition, and ethical transformation by integrating Spinozist metaphysics with contemporary scientific modeling, particularly chaos theory and nonlinear science. The synthesis of metaphysical insight and scientific modeling reveals a recursive movement between thought and being, positioning the human mind not as a passive observer but as an active participant in nature's infinite expression. Drawing on Spinoza's substance-based ontology and the distinction between inadequate and adequate ideas, scientific visualization tools are interpreted not as external representations but as expressions of immanent order; bifurcation diagrams and fractal structures are reframed as epistemic thresholds that foster intuitive understanding and ethical reorientation. The article also highlights the educational dimension, suggesting that higher education should cultivate adequate ideas through engagement with complexity, linking philosophical insight with scientific visualization to deepen comprehension and ethical practice.

Keywords: God; nature; human; necessity; freedom; chaos theory; nonlinear systems.

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1. Introduction

In Spinoza's philosophy, nature operates according to a necessary and deterministic order to which all beings, including human thought and action, are subject. This raises a classical tension: If everything arises through necessity, how can freedom be meaningfully conceived? To speak of a rigid deterministic ethics that abolishes the sense of freedom constitutes a "contradictio in terminis" (a self-contradictory expression) (Lucero-Montaño, 2012). In the *Ethica*, particularly in Part V, Spinoza grounds human freedom not as an exemption from causality, but as acting in harmony with necessity through adequate ideas based on the knowledge of necessity (Spinoza, 2002a). Yet reconciling this conception with classical deterministic laws of nature remains difficult.

Contemporary scientific paradigms, particularly chaos theory, challenge the classical conception of determinism by revealing the existence of systems that are both causally determined and unpredictable, thereby elevating classical causality to a more complex level. This paradox of deterministic unpredictability finds a powerful philosophical counterpart in Baruch Spinoza's metaphysics: for Spinoza, freedom is not the opposite of necessity, but a mode of existence made possible through the knowledge of necessity. By redefining the relationship between freedom and necessity, Spinoza's philosophy conceives freedom not as the absence of external constraints, but as the knowledge of inner necessity. This article argues that chaos theory and nonlinear science provide a conceptual and visual framework through which Spinoza's metaphysics can be reinterpreted. Chaotic systems are causally determined yet practically unpredictable, and this unpredictability should not be mistaken for ontological indeterminacy. Chaotic deterministic systems may appear observationally equivalent to indeterministic ones due to their practical unpredictability; however, this equivalence does not imply ontological indeterminacy but rather reflects epistemic limitations (Bishop, 2008; Werndl, 2010). In chaotic systems, small changes in initial conditions lead to large and unpredictable outcomes; yet these systems simultaneously exhibit deep patterns, bifurcations, and fractal structures that reflect an underlying order. These dynamics resonate with Spinoza's ontological model, grounded in the essence of modes expressed through the infinite attributes of substance, and with his epistemological model, in which human cognition evolves from inadequate ideas to adequate ideas.

In the current study, Spinoza's ontology is approached not as a static metaphysical doctrine, but as a dynamic framework for rethinking cognition, freedom, and education. By bringing the concepts of Spinoza's philosophy into dialogue with scientific visualization, we aim to show how metaphysical insight can influence ethical and pedagogical transformation. Evaluating necessity through chaos theory and nonlinear science may provide a deeper understanding of Spinoza's philosophy; at the same time, Spinoza's ontological and epistemological approach can contribute to the development of these scientific fields.

2. Chaos theory and nonlinear science

Potentially chaotic structures are nonlinear feedback systems that exhibit a strong dependence on initial conditions (Cramer, 1993). In his 1903 book *Science and Method*, Jules Henri Poincaré argued that if we knew the initial conditions of the universe precisely, we could predict its subsequent states; yet even the smallest variations in those initial conditions could lead to major differences, making the outcome knowable only approximately rather than with certainty (Poincaré, 1914). Although mathematicians such as George D. Birkhoff—who for a time taught Edward Lorenz at Massachusetts Institute of Technology—showed interest in Poincaré's approach, it did not gain a foothold in science until Lorenz's observations (Gleick, 1987). In his 1963 paper, Lorenz (1963) demonstrated that systems which do not repeat periodically are highly sensitive to initial conditions, where minute changes can result in large-scale differences. As Poincaré (1914) had already noted, scientists were aware of the difficulty of predicting outcomes in multivariable nonlinear systems, and of the fact that small changes in initial conditions could produce major transformations. The significance of Lorenz's paper lay in showing that even nonlinear systems with relatively few phase-space dimensions present insurmountable challenges. This scientific domain, widely known as the "butterfly effect" and "chaos theory," was termed "nonlinear science" by physicist Joseph Ford in a 1977 letter to colleagues (Scott, 2007). Scott (2007) later defined nonlinear science, which rapidly developed after the 1970s, as the study of phenomena in which the whole is different from the sum of its parts, emphasizing that it represents a Kuhnian revolution with profound consequences for scientific research in the twenty-first century. In comparison, classical science privileged order and stability; oscillation and instability play a fundamental role at every stage of observation (Ruelle, 1991). Within the research domains of modern science, the diversity of processes sensitive to initial conditions, including physical (such as weather forecasting, turbulence, and phase transitions like freezing and the superfluidity of helium), biological (cardiac fibrillation, morphogenesis, flocking behavior of birds), economic (stock market and financial fluctuations), and socio-psychological (language development, cultural patterns, war hysteria), constitutes the primary subject of nonlinear science (Scott, 2007).

Chaos theory has compelled a reconsideration of classical causality by showing that deterministic systems can

exhibit unpredictable behavior. In this context, nonlinear dynamical systems are understood as structures that, beyond fixed equilibrium points, may evolve into bifurcation, oscillation, and irregularity. Bifurcation observed in nonlinear systems arises when system parameters reach critical thresholds. May's (1976) population models provide striking examples of how this phenomenon operates within biological systems. May's (1976) logistic map visualizes chaos as a mathematical representation of sensitivity to initial conditions and unpredictability. As illustrated in Figure 1, this model reveals that population fluctuations, which at first appear random, display bifurcation patterns under certain parameter values.

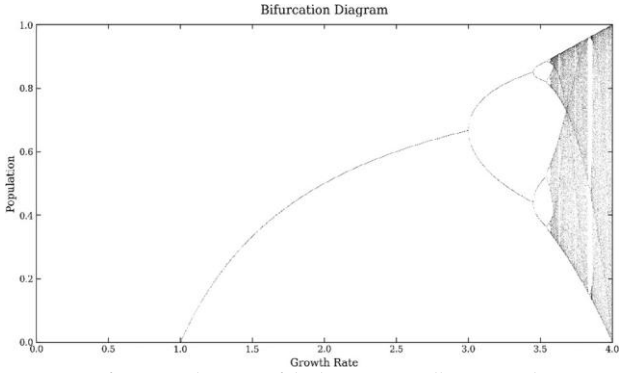


Figure 1. Bifurcation diagram of the logistic map illustrating the transition from stability to chaos as the growth rate increases. Re-created based on May (1976).

These patterns visualize how deterministic systems can display complex and branching behaviors. The bifurcation process begins when, within certain parameter ranges, the system enters an oscillatory and irregular phase. As the parameter value increases, the system undergoes successive bifurcations, splitting first into two, then four, eight, and further periodic cycles. This period-doubling process eventually evolves into unpredictable and chaotic behavior once a threshold is crossed. The ratios of these bifurcations are defined by a constant discovered by Mitchell Feigenbaum (1944–2019), universally observed in chaotic systems: the Feigenbaum constant ($\delta \approx 4.669$) (Feigenbaum, 1979). This constant, expressed as the ratio of distances between successive bifurcation points, reveals the universal nature of the transition to chaos across different physical systems. In the chaotic region, these bifurcations progress through a perioddoubling cascade that increasingly approaches the Feigenbaum constant, and, intriguingly, they display a pattern that replicates itself at every scale. When one magnifies a single branch, its structure reproduces the form of its smaller counterpart in precisely the same manner (Stewart, 1990). The schematic representation of this pattern is provided in Figure 2.

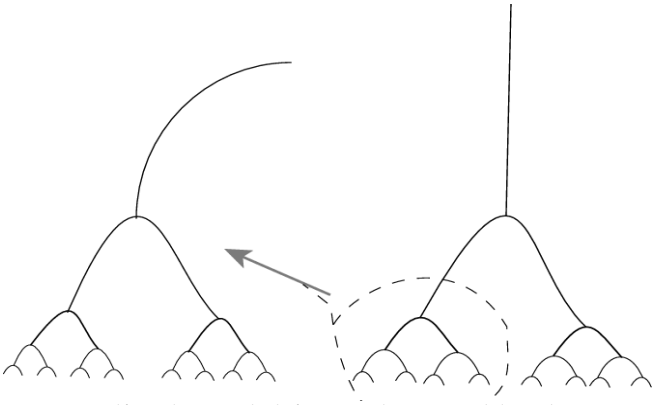


Figure 2. Self-similarity in the bifurcation diagram; each branch reproduces the overall structure at a smaller scale, illustrating the universal scaling ratio. Re-created based on Stewart (1990).

The Feigenbaum constant demonstrates that chaotic systems embody not randomness alone, but a hidden structural order within their complexity. This creates an intriguing parallel with Spinoza's conception of necessity: While nature operates within a necessary order in Spinoza's philosophy, chaos theory uncovers the unpredictability inherent within that necessity. In this sense, chaotic systems are both causal and indeterminate, offering an ontological ground that resonates with Spinoza's definition of freedom as "acting through the knowledge of necessity." Philosophically, the Feigenbaum constant aligns with Spinoza's claim that necessity in nature is rationally comprehensible. Although nature appears complex and multifaceted, beneath this complexity lies a universal order and principle of causality. This resonates with Spinoza's view that "Things could not have been produced by God in any other way or in any other order than is the case" (Spinoza, 2002a, p. 236), and finds a suggestive parallel in the visual and numerical models of chaos theory. The visual and structural representation of chaotic systems becomes possible through fractal geometry. Benoît Mandelbrot (1924–2010) named this field "fractal geometry," which studies structures that endlessly subdivide into smaller parts while repeating the same form, describing complex and self-repeating patterns observed in nature (Mandelbrot, 1982). Fractal structures, with their infinite detail and scale-independent properties, can be taken as analogies that help us grasp the immanent order of nature and its layers of causality, rather than as literal or ontological representations. Prior to Mandelbrot's formalization of fractal geometry, works relevant to it during what he called mathematics' "crisis period" (1875–1925) included Cantor's set theory, Peano's space-filling curve, and Sierpinski's gasket (Mandelbrot, 1982). Among these was the Sierpinski gasket, defined by Wacław Sierpiński (1882–1969) in 1916. It is constructed by connecting the midpoints of a triangle's sides to form an inverted triangle, which is then removed. The same operation is applied recursively to the remaining

triangles ad infinitum (Gribbin, 2004). The resulting structure, the Sierpinski gasket, is a fractal. Figure 3 illustrates the drawing of the Sierpinski gasket.

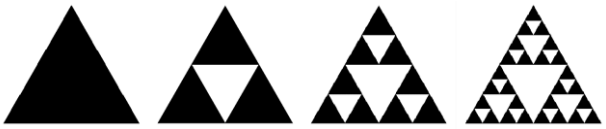


Figure 3. The Sierpinski gasket. Re-created based on Mandelbrot (1982).

1. Despite their important conceptual differences, stochastic randomness and deterministic chaos may sometimes appear similar. This resemblance, however, does not erase the distinction: stochastic processes involve genuine randomness, whereas chaotic dynamics remain causally determined but epistemically unpredictable (Bertin, 2012). It is important to recognize that symmetric and orderly fractal structures can be generated entirely through randomness. At the onset of chaos, developments appear wholly random and devoid of order. Yet, when sufficient data is examined, chaotic systems can be seen to progress according to specific ratios and patterns. Similarly, fractal structures can be produced through extensive use of randomness. The Sierpinski gasket, a fractal mentioned earlier, can be constructed randomly (Gribbin, 2004). To do so, three points forming an equilateral triangle are defined on a plane and labeled 1, 2, and 3. A point is then marked at any random location outside these vertices. By a process akin to rolling dice, one of the three numbers is selected in a fully random manner. If dice are used, the first three faces correspond to the triangle's vertices, while the remaining faces are mapped as 4 → 1, 5 → 2, and 6 → 3. The midpoint between the initial point and the chosen vertex is then marked. This newly marked point becomes the new starting point, and another random number is selected. The midpoint between this new starting point and the corresponding vertex is again marked. After many iterations, the emerging pattern of point son the paper begins to form the shape of the Sierpinski gasket (Gribbin, 2004). Although the initial point is located outside the triangle, it is gradually drawn toward the vertices. Thus, by applying a simple rule in a wholly random manner, the fractal pattern of the Sierpinski gasket can be generated. Figures 4 and 5 illustrate the first six steps and the 10,000th step of constructing the Sierpinski gasket through randomness (Gribbin, 2004). This demonstrates the need to reconsider the relationship between randomness, order, and chaos. In this way, fractal geometry reveals how randomness itself can generate order, offering a conceptual bridge between chaos theory and Spinoza's metaphysics. Fractal geometry demonstrates that randomness can generate order, or conversely, that order may appear as randomness unless grasped through deeper understanding. In doing so, it establishes a conceptual bridge between chaos theory and Spinoza's metaphysics.

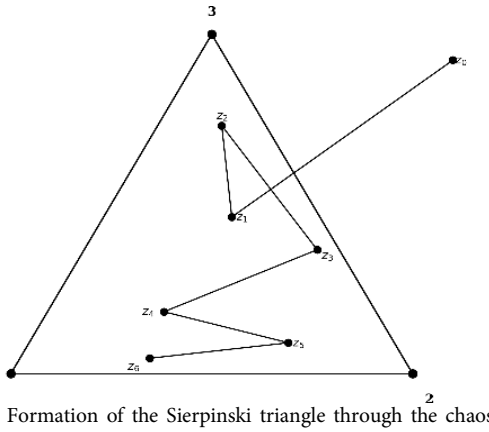


Figure 4. Formation of the Sierpinski triangle through the chaos game, showing the first six iterations. Re-created based on Gribbin (2004).

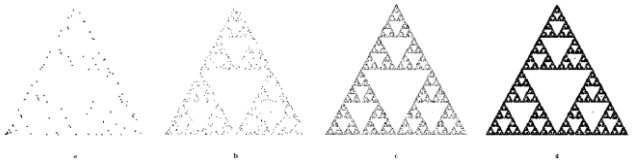


Figure 5. Formation of the Sierpinski triangle through the chaos game, showing the states after 100, 500, 1,000, and 10,000 steps. Re-created based on Gribbin (2004).

Fractal structures can also be generated through iterative functions. For example, the Mandelbrot set, although defined by a simple iterative equation with complex numbers, exhibits a geometric form of infinite complexity (Peitgen & Richter, 1986). This structure reveals that beneath an apparently chaotic system lie necessary laws and a simple order—just as in Spinoza's conception of nature, where "conformity to law is the common principle of all attributes of substance" (Kline, 1952, p. 80). These iterative structures can be related to Spinoza's concept of modus. Each fractal pattern may be considered a modus expressing one of the infinite attributes of substance. In this way, fractal geometry can be taken as a visual analog of Spinozist ontology: infinity, order, and complexity interweave. The self-similarity expressed by fractal structures can be interpreted as a suggestive parallel to Spinoza's notion of nature expressing itself.

3. Spinoza's ontology and epistemology

Spinoza's philosophy integrates ontology and epistemology as mutually constitutive dimensions of a single system. The nexus between being and knowing unfolds from his conception of God/Nature, through the ontological and epistemological positioning of the human being, to the problem of necessity and freedom. To apprehend this framework requires tracing how the expression of God/Nature grounds human existence, and how this grounding opens the way to Spinoza's resolution of the tension between

necessity and freedom—a trajectory that will be pursued in the following subsections.

3.1. Spinoza's conception of God/Nature

Spinoza's philosophy is founded upon a single substance. He transforms his ontological determination into a theological analysis by identifying substance with God. God/Nature,[1] as the only existing substance, contains both essence and existence together (Spinoza, 2002a). This substance possesses an eternal existence, existing independently of anything else, being self-caused (*causa sui*) (Spinoza, 2002a). The best way to grasp substance, to understand what kind of being it is, is to examine its attributes (Elmas, 2015). In Spinoza, an attribute is what the intellect perceives as constituting the essence of substance. Attributes form the essence of substance, that is, its true nature and reality. One of the cornerstones of Spinoza's ontology is the concept of modus (mode). Between substance, attribute, and mode there exists a relation of explanation and inclusion: while attributes constitute the essence of substance, modes are particular modifications of these attributes.

Modes are finite manifestations of God's power. Every finite being, as a mode, is an expression of God's infinite nature. This expression involves qualitative differentiation in mediated and immediate modes, and quantitative differentiation in finite modes. Yet finite modes are not deviations from the absolute nature of substance, but rather its limited appearances. The comprehension of substance is possible only through its manifestations, that is, its modes (Spinoza, 2002a). The conception that defines God not as a transcendent creator of the universe but as identical with the Universe and Nature is a relatively novel proposal in the history of Western philosophy (Fransez, 2020). The ontological unity of substance finds its expression in the domain of finite modes as quantitative multiplicity, articulated through the modifications of attributes. The differentiation of attributes as modifications is not a creation, a derivation, or an appearance elsewhere, but a production. Attributes exist in God/Nature—the one substance—as qualitative essences and embody the absolute power of God/Nature. The differentiation of modes from attributes is entirely qualitative (Deleuze, 1992). Yet the visible form of this differentiation, or the form accessible to human cognition, is quantitative. Human beings apprehend modes in this quantitative aspect. Everything that comes into being arises according to the laws of God's infinite nature and necessarily follows from its essence (Spinoza, 2002a). The infinite modal essences of existing quantitative finite modes contain physical reality (Deleuze, 1992). The transition from the infinite modal essences, which are modifications of attributes and degrees of power, to finite modes—that is, from the laws of Divine Nature (*Natura Naturans*) to the laws of Nature (*Natura Naturata*)—is not easy to grasp. In Spinoza's philosophy, things can be apprehended in two ways: either under the aspect of imagination (*sub specie durationis*), or under the aspect of reason and eternity (*sub specie aeternitatis*). Within the domain of finite modes, we do not struggle to imagine what we understand; yet as we approach the domain of modal essences, this difficulty becomes pronounced, and even what we can understand resists imaginative representation (Spinoza, 2002b). It becomes clear here that the use of numbers is not appropriate to the essences of modes. For the essences of modes are not quantitative; they exhibit a qualitative differentiation from substance. While we can understand and imagine finite modes quantitatively, even if we understand modal essences, we cannot imagine them. To grasp the physical reality of modal essences requires a different approach and mode of comprehension. This

difficulty is also evident in the attempt to comprehend nonlinear science through linear science. The challenge we face in trying to understand nonlinear science or chaos theory by means of linear science intensifies as we approach the physical reality of modal essences, making comprehension increasingly difficult. Numbers, while serving as a way of imagining quantity and abstractly conceiving modes, cannot adequately reflect the nature of modes. They are merely a form of imagining quantity and a method of abstract thought. When we explain modes through numbers, we overlook their real existence and grasp only constructs (Deleuze, 1992). This approach is deeply consonant with the nonlinear causality model offered by chaos theory. Chaos theory shows that complex systems operate according to determinate rules, though these rules remain hidden within apparent disorder. Likewise, in Spinoza, nature is a system operating through the modifications of infinite attributes; its complexity arises not from its unintelligibility, but from the limitations of human reason.

In Spinoza, the conception of God/Nature is not merely a metaphysical principle but also an epistemological limit. Human beings can know God only through the modifications of His attributes. When this process of recognition is supported by the visualization tools offered by chaos theory, the order within necessity becomes more

[1] By the term God/Nature (Divine Nature, Productive Nature, *Natura Naturans*), we understand the one substance that contains infinite attributes (*Deus sive Natura*). When we use the term Nature, we refer to the mode of God/Nature's attribute of extension as it is manifested in motion—that is, Produced Nature (*Natura Naturata*).

evident. In this way, Spinoza's conception of God/Nature can be reinterpreted both on the philosophical and the scientific level.

3.2. The human being in Spinoza: An ontological and epistemological positioning

In Spinoza's philosophy, the human being is conceived as a manifestation of the infinite attributes of God/Nature (*Deus sive Natura*). In the first part of the *Ethica*, the ontological structure is established upon God as the one substance, constituted by infinite attributes that express the absolutely infinite and unlimited essence (Spinoza, 2002a). In the second part, the place of the human being within this structure is examined. The first nine propositions of Part II set forth how the human being is situated within this divine framework.

Accordingly, the human being, who can apprehend the modifications of the attribute of thought—through which self-awareness is possible—and of the attribute of extension—through which corporeal reality is constituted—is a small model of Divine Nature (Fransez, 2020). Just as the infinite divine intellect comprehends the whole of God/Nature, so too the human mind becomes aware of the corporeal constitution of the human body, which is itself a part of nature (Spinoza, 2002b). In this respect, the first nine propositions of Part II provide the transition from the God/Nature described in Part I to the human mind and body (Fransez, 2020). In Proposition X, it is stated that the essence of the human being does not derive directly from substance itself, but from specific modifications (*modificatio*) of the attributes of the one substance, God. Since the idea that first constitutes the human mind is a modification of the attribute of thought, the human mind is a part of God's infinite intellect. This constitutive idea is not the idea of something non-existent, but of a singular existing thing. The object of this idea, which constitutes the human mind, is the body; and the mind must perceive everything that occurs within the body (Spinoza, 2002a). Thus, in Proposition XIII, where it is concluded that the human being consists of mind and body, the fundamental structure of the human being is established: the mind as a modification of the attribute of thought, and the body as a modification of the attribute of extension. Every body is composed of infinite singular and composite parts (Elmas, 2018). The human body, as a modification of the attribute of extension, is a singular unit formed by the infinite interactions of many singular bodies coming together, themselves counted as singular bodies, which in turn constitute composite bodies through their union (Spinoza, 2002a).

Descartes had previously introduced the term idea, which originally denoted perception belonging to the divine mind, in a sense applicable to the human mind (Nadler, 2006). Spinoza, however, was concerned with how ideas are formed as knowledge of the body, of the body's external interactions, of the mind, and of God/ Nature (Nadler, 2006). Spinoza distinguishes four kinds of perception and, arising from them, three kinds of knowledge. The first kind of knowledge is formed through hearsay and everyday experience—that is, through perceptions that do not contribute effectively to the determination of the faculty of understanding. Perceptions that result from the inference of the essence of one thing from another, but without sufficient adequacy, constitute the second kind of knowledge, or reason. The third kind of knowledge, or intuitive knowledge, arises when a thing is perceived solely through its essence, or through the correct knowledge of its proximate cause (Spinoza, 2002a, 2002c).

The "natural state of mind" of human beings is largely shaped by the first kind of knowledge—opinion or imagination—arising from the use of the first two kinds of perception. As Spinoza illustrates, although we perceive the sun as being at a certain distance, we can, through reasoning, discover that it is in fact much farther away. Yet even in this case, although we know by reasoning that the sun is much more distant, in practice we still rely on the perception that presents it as near (Spinoza, 2002a). The fourth kind of perception gives rise to intuitive knowledge, which spans a spectrum from adequate ideas concerning the formal essence of God's attributes to knowledge of the essence of things (Spinoza, 2002a). Every idea that is absolute, that is, adequate, is true (Spinoza, 2002a). Ideas in the mind are adequate and true if they originate from absolute, adequate ideas. Since elements common to all things—present equally in both the part and the whole— can be adequately grasped, certain ideas and concepts are shared among all human beings (Spinoza, 2002a). Because the "natural state of mind" of human beings is shaped largely by the first kind of knowledge, opinion, or imagination, resulting from the use of the first two kinds of perception, in Spinoza's view the human being is situated predominantly under the dominion of inadequate ideas, as a being subject to external necessities. Yet by cultivating reason and intuitive knowledge, the human being can be liberated from the bondage of the passions and approach freedom through a state of mind governed by adequate ideas. This process requires a transformation in the state of consciousness: a transition from the dominion of emotions and confused ideas to the dominion of adequate ideas and intuitive knowledge. In this way, the human being can grasp the necessities of nature more profoundly and attain a conception of freedom in accordance with one's own essence.

3.3. Necessity and freedom in Spinoza

In Spinoza, it is affirmed that everything in nature can exist and act only through a deterministic chain of causes, and

that all human actions and thoughts are likewise subject to these necessities. In Propositions 26 and 27 of Part I of the *Ethica*, it is stated that everything that exists is necessarily determined to act by God, and that this determination cannot be altered (Spinoza, 2002a). The first approach suggesting that Spinoza's conception of necessity contains an element of contingency appears in Edwin Curley's *Spinoza's Metaphysics* (Curley, 1969). Curley's interpretation is based on Proposition 28 of Part I, which requires that every singular thing possessing finite and limited existence must be determined to exist and act by a cause that is itself finite and limited (Spinoza, 2002a). According to Proposition 28, every singular thing as a finite mode must be determined to exist and act by another singular finite cause; otherwise, it cannot exist. While Proposition 26 asserts that everything is determined to act by God, Proposition 28 emphasizes that finite singular things are determined to exist and act by other finite singular things. Although at first glance these two propositions may appear contradictory, upon closer examination it becomes clear that they complement one another. Every causal relation among finite modes is simultaneously the result of their own interrelations and of the causal order grounded in the laws and properties of infinite modes. If we conceive of causal relations among finite modes (*Natura Naturata*) as occurring on a horizontal plane, and causal relations among infinite modes (*Natura Naturans*) as occurring on a vertical plane, then every event in the domain of finite modes takes place at the intersection of these two planes. The horizontal plane represents the temporally bound deterministic causal relations among finite modes within the particular domain of *Natura Naturata*. The vertical plane represents the dimension in which causal relations are determined by eternal principles (Nadler, 2006). Interpreting the interaction of causality across these two planes within a multidimensional framework informed by chaos theory and nonlinear science can greatly facilitate our understanding of Spinoza's philosophy.

Spinoza defines a true idea as one that corresponds to its object, and an adequate idea as one that explains the efficient cause of its object or possesses internal marks of truth independently of its object. Since the human mind does not possess adequate knowledge of the parts that constitute the body, it does not apprehend objects absolutely but only through the modifications it undergoes. For this reason, ideas derived from perception are confused. Because such ideas, originating from the body and other bodies, dominate the mind, adequate ideas are not immediately present in human beings (Deleuze, 1988).

The state of mind is the idea of an idea, and it reveals the condition of human consciousness (Deleuze, 1988). In human beings, this state of mind—formed under the dominance of inadequate ideas arising from the body and from the knowledge of the body's existence—relies upon the first kind of knowledge, produced by the first and second kinds of perception. Thus, the human being acts in accordance with the definition of a "spiritual automaton" (Spinoza, 2002c), behaving in line with a mental state shaped by necessities intertwined with contingency, and determining decisions under the compulsion generated by this state of mind.

Liberation from the bondage of the passions and the attainment of a state of mind governed by adequate ideas is possible only through the faculty of understanding, the manifestation of the attribute of thought as we know it, by which the human being can reach the third kind of knowledge—intuition. To increase the possibility of attaining intuitive knowledge through the use of the second kind of knowledge, a transformation of consciousness is required: A state in which ideas derived from the essence of modes prevail, a condition that may be termed "intuitive consciousness." Through this state, the human being can more adequately grasp and comprehend the reality of nature in accordance with its essence. What is meant by intuitive consciousness is a mental state in which adequate ideas, arising from the very nature of thought, become increasingly more effective and dominant in the mind, thereby gaining ascendancy over inadequate ideas that originate from the spatial modifications of the body. This state represents not only an epistemological progression toward Spinoza's *scientia intuitiva*, but also a transformation in the balance of consciousness: A diminution of confused, passion-driven perceptions and a rise of adequate ideas rooted in the mode of thought. Consequently, intuitive consciousness signifies the transition from a mind governed by external necessity to one attuned to the internal necessity of its own essence. In this sense, by "intuitive consciousness," we propose a contemporary reconstruction inspired by Spinoza's scientia intuitiva, defining a transformation of the natural state of mind in which the ascendancy of adequate ideas over inadequate ones occurs inseparably and simultaneously with the ethical conversion required to secure inner coherence, thereby enabling the grasp and use of intuitive knowledge and the essence of things.

In Spinoza, freedom is not a rupture independent of the necessary order of nature, but a mode of action in harmony with the knowledge of that order (Sørensen, 2005). The attainment of freedom by the human being depends upon recognizing the passive affects and confused ideas that dominate the natural state of mind, and transforming them into adequate ideas. The mental state produced by this

transformation renders the human being more active and virtuous in the face of nature's necessities. Thus, the human being who acts through reason and attains a state of mind capable of reaching and employing intuitive knowledge can grasp the necessities of nature more profoundly and partake more fully in divine freedom. For absolute freedom belongs only to God/Nature, and human freedom is always a matter of degree (Gatens, 2021).

4. Rethinking freedom in a chaotic context

Spinoza's theory of knowledge grounds the distinction between inadequate and adequate ideas in the mechanisms of imagination and reason. Imagination, according to Spinoza, is the passive reception of external impressions by the mind; these impressions are generally confused and lack causal comprehension. Hence, inadequate ideas arise not from essence but from contingent encounters. In this sense, imagination represents the threshold of epistemic limitation, a plane in which the mind is passive rather than active. Neuroscientific evidence shows that decisions are initiated prior to conscious thought, suggesting that in the natural state of mind cognition remains fundamentally passive (Tadić, 2026). Yet at epistemic thresholds—similar to bifurcations in chaotic systems—the mind may leap into intuitive knowledge, reconfiguring freedom beyond mere contingency. Chaos theory renders this dynamic even more visible. As a system approaches a bifurcation point, uncertainty increases, and predictability diminishes. When uncertainty reaches its peak, the system reorganizes itself into a new order; bifurcation proceeds not randomly but according to a universal ratio. This ratio marks the threshold at which immanent order becomes manifest—the necessity within chaos. Prior to each bifurcation, uncertainty intensifies; yet only at critical thresholds does the system radically alter its behavior and reconstitute itself within a new order. This transition signals the emergence of a universal order from chaotic complexity. Similarly, the human mind governed by imagination approaches an epistemic bifurcation threshold, where multiple, conflicting interpretations compete. The transition to adequate ideas resembles a phase shift: the system reorganizes itself not around external contingencies but around internal necessity. In this respect, the chaotic environment produced by the first kind of knowledge is both a limit and a potential: it is the condition in which reason must emerge and the ground upon which freedom is constructed. At this stage, the employment of the second kind of knowledge (reason) and the third kind of knowledge (intuition) enables the phase transition to evolve into a universal order. In Spinoza's epistemology, intuitive knowledge (*scientia intuitiva*) represents the highest level of cognition, arising when the individual directly apprehends his own essence within the nature of God. Intuition is neither confused like imagination nor inferential like reason; it embodies immediacy and wholeness. For this reason, intuition is not merely an epistemic faculty but also an instrument of ethical transformation: through intuition, the human being comprehends necessity and acts in harmony with it. Epistemic reorganization begins with this intuitive apprehension. Knowledge accumulated at the levels of imagination and reason is reconstituted into a new order through intuition. This process resembles the phase transitions of chaos theory: the system moves from a state of indeterminacy to a structured order. When the mind begins to generate adequate ideas at bifurcation points, intuition intervenes and restructures knowledge. This reorganization is not only cognitive but also existential and ethical, for the human being ceases to be carried along by contingent images and instead comes to know the true causes of his actions by grasping the necessary order of his own nature. The one who achieves this can ultimately bring all of his conduct under the dominion of reason (Spinoza, 2002a).

According to Spinoza, intuition is the most direct way of apprehending God as infinite necessity. This apprehension enables the individual to situate his own modal essence within the universal order. Thus, intuition establishes a bridge between individual knowledge and cosmic order. The visualization tools offered by chaos theory reveal the mathematical traces of this bridge: fractal structures and bifurcation diagrams. These structures can be read as the formal counterparts of intuitive knowledge.

If we position freedom not in the classical sense of "liberty of action" but as "capacity to understand," then Spinoza's conception of freedom can be defined not as independence from external causes, but as the ability to act in harmony with them by grasping their inner structure (James, 1996). In this respect, freedom must be redefined not only as an ontological power but also as an epistemological competence; thus, it becomes an active capacity for action guided by the comprehension of external causes at the level of adequate ideas.

5. Conclusion

This study proposes a new interpretation of the functioning of the universe by establishing a relationship between Spinoza's necessity-based conception of nature and the mathematical structures of chaos theory. The bifurcation process observed in the logistic equation reveals the system's transition from periodic to chaotic behavior within certain parameter ranges, while the Feigenbaum constant represents the universal order underlying this transition. In this context, the fact that even processes that appear chaotic are subject to specific ratios and structural necessities

supports the idea of an immanent order consistent with Spinoza's conception of nature.

The article proposes a reconsideration of the boundary between necessity and contingency on both philosophical and mathematical levels. When evaluated together with Spinoza's principle that "only that which exists by the necessity of its own nature and determines its actions solely by itself is free" (Spinoza, 2002a, p. 217), the regulation of chaos through universal constants suggests that freedom may be conceived as having a mathematical structure. This approach demonstrates that the laws of nature must be understood not only on the physical level but also on the ontological and epistemological levels.

The deterministic yet unpredictable structure offered by chaos theory corresponds to Spinoza's ontological concept of necessity; at the same time, the possibility of reaching the essence of modes through intuitive knowledge allows for a redefinition of the concept of freedom. In this context, human subjection to the necessities of nature is conceived not merely as bondage, but also as a condition that can be overcome through knowledge. When Spinoza's perspective sub specie aeternitatis is considered together with the immanent order of chaotic systems, freedom appears not only as an ethical ideal but also as an ontological possibility inherent in nature. Yet the realization of this possibility at the level of the individual depends not only on epistemic competence, but also on the transformation of this competence into mental activity through adequate ideas—that is, upon a state of mind capable of grasping the immanent causes of necessity.

It appears important that this issue find application within the field of pedagogy. If freedom is understood as the capacity to act through understanding, then education must aim at the cultivation of adequate ideas. In Spinoza's terms, this means progressing beyond imagination toward reason and intuition. Scientific visualization, particularly in complex systems, facilitates the intuitive apprehension of immanent order. In this way, learning becomes not merely the acquisition of knowledge but a process of liberation through the understanding of causes. Therefore, higher education should not only transmit knowledge but also foster epistemic transformation. Educators, by integrating metaphysical insight with scientific modeling, can help students develop not only knowledge about nature but also the capacity to think with nature. This entails the cultivation of intellectual virtues: clarity, coherence, and ethical sensitivity. In this light, the university becomes not merely a site of knowledge production but also a space for ethical transformation. The aim is not to dominate nature but to participate in its unfolding—an education that aligns cognition with necessity and transforms freedom into a lived practice.

The interdisciplinary relationship established between Spinoza's philosophy and chaos theory demonstrates both that philosophical thought can be reinterpreted in light of contemporary scientific developments and that the concept of freedom can be grounded in a deeper ontological foundation. This approach not only offers a new perspective on Spinoza's thought but also shows that a productive dialogue between science and philosophy is possible. A new scientific paradigm arising from the philosophical interpretation of nonlinear science—such as the attempt to understand the place of chaos theory within Spinoza's philosophy—together with scientific advances capable of explaining nature and the universe in all their dimensions, may help us to comprehend the eternal and inviolable law of nature (*Naturae ordinem*) in the *Political Treatise* (Spinoza, 2002d), which derives from the necessity of divine nature and is bound to the existence of God/ Nature with the same freedom.

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