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To cite this article: Michal Oleksowicz (18 Jul 2024): New Mechanistic Explanation: Can It Be Interesting for a Theologian, *Theology and Science*, DOI: [10.1080/14746700.2024.2351642](https://doi.org/10.1080/14746700.2024.2351642)

To link to this article: <https://doi.org/10.1080/14746700.2024.2351642>



Published online: 18 Jul 2024.



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New Mechanistic Explanation: Can It Be Interesting for a Theologian

Michał Oleksowicz 

ABSTRACT

“Mechanism” is one of the crucial concepts that have deeply influenced the evolution of scientific disciplines and philosophical systems. For the last few decades, this concept has again found itself at the center of the philosophical debate about science and scientific methods with the emergence of the new mechanical philosophy (NMP). The aim of this paper is to counter the argument that there is or should be an essential conflict between the modern mechanical philosophy (MMP) or the NMP and Christian theology.

KEYWORDS

New mechanical philosophy; naturalism; metaphysical reductionism; methodological reductionism; theology of science

Introduction

The term “mechanism” is used in many ways and in various contexts. The default sense of the word pertains to the idea of something compound that: 1) can be explained in terms of size, shape and motion; and 2) is made up of parts that together carry out a task or function. For instance, Nicholson distinguishes three basic meanings of “mechanism” in view of its historical evolution: mechanicism (the philosophical thesis that conceives of living organisms as machines), machine mechanism (the internal workings of a machine-like structure) and causal mechanism (a step-by-step explanation of the mode of operation of a causal process).¹

From an historical point of view, “mechanism” is one of the crucial concepts that have not only deeply influenced the evolution of scientific disciplines and practice but also shaped the philosophical world picture. Since the mechanical philosophy is a very complex historiographical category,² my aim here is not to provide a fine-grained historical evaluation. Although it was mainly in the early modern period that various natural philosophers put forward the philosophical program that would later be called “the mechanical philosophy” (hereinafter MMP, i.e. modern mechanical philosophy), the concept of mechanism has once again found itself at the center of the philosophical debate about science with the new mechanical philosophy (NMP).

It is not an easy task to define the NMP in a few sentences, since one should acknowledge not only its complex historical roots but also the fact that positions within the NMP itself have developed and sometimes shifted over the last twenty years.³ I cannot discuss all the historical and conceptual details of the NMP here, but to begin with, it can be said that the NMP is, to a certain degree, a novel revision of the MMP. If it is so, then I feel obligated to define what the MMP is. In fact, there were few people (besides R. Boyle perhaps) in the seventeenth century who would refer to themselves as mechanical

philosophers. Moreover, not all of them would have compared the world to a machine, and some might even have thought of a world governed by mathematical laws instead. For the purposes of my discussion, I have assumed (as the secondary literature has also tended to do) that the canonical statement of the MMP, positively identified through its main tenets, can be found in the widely influential work that Boyle published in 1666, *The Origin of Forms and Qualities According to the Corpuscular Philosophy*. The book is, in a sense, a manifesto for the explanatory program of Boyle's mechanical philosophy. Since the publication of that manifesto, various modern thinkers can be reasonably considered to have been practitioners of the mechanical philosophy,⁴ although bearing in mind that this is a very coarse-grained approximation. While it would be historically incorrect to state that there was an actual and unified movement called "MMP," its existence is, unfortunately, widely assumed in the historiography. For my aims, it suffices to say that the NMP can be characterized by both continuity and discontinuity with the MMP: continuity, because the NMP takes into account phenomena explained in terms of parts and activities; and discontinuity, because the NMP explains nature as being made up of complex systems and offers an overview of various methodologies employed in different sciences (e.g. cognitive science, medicine, epidemiology, physics, social sciences, etc.). The NMP takes into account the concept of "mechanisms" both as complex causal systems and as heuristic tools for discovering such complex systems in the world. As a consequence, the NMP investigates nature through the explanatory demands specific to particular scientific fields.

The notion of mechanism has been one of the most widely developed concepts in the philosophy of science in the last five decades. On the one hand, there has been an extensive discussion on the definition of mechanisms and the main tenets of the so-called mechanistic explanation (MEx), and on the other, there has been a debate on the feasibility of this type of explanation in various disciplinary contexts. At this point, I would like to comment briefly on these two aspects.

According to the NMP, MEx is essentially held to "explain *why* by explaining *how*."⁵ The following quote from S. Glennan aptly demonstrates the main idea of MEx:

The process of mechanistic explanation requires one to formulate, perhaps in very sketchy terms, a mechanical model. The two parts of this model, the behavioral and the mechanical descriptions, are respectively the explanandum and explanans in the mechanistic explanation. . . . While it is sometimes the case that a description of the parts of the mechanism will entail a description of the mechanism's outward behavior, the explanation lies not in the logical relationship between these descriptions but in the causal relationships between the parts of the mechanism that produce the behavior described.⁶

The explanatory force of MEx therefore comes in two steps: 1) a demonstration of mechanical models which refers to real and relevant entities and activities and whose behavior reproduces the *explanandum* phenomenon; and 2) a causal story that provides intelligibility to the model of a mechanism by describing how the entities and activities of that mechanism are organized so as to bring about the *explanandum*.

New mechanists inherited the term "mechanism" from the past centuries, but their way of understanding mechanisms was primarily elaborated as part of an analysis of the actual investigatory practices of the sciences rather than as part of any given metaphysical view. For instance, W. Salmon turned to the concept of mechanism to

explain processes in physics,⁷ W. Bechtel and R. Richardson evaluated the discovery of mechanisms in the neurosciences,⁸ P. Hedström and R. Swedberg proposed mechanistically-oriented social theories,⁹ and K. Schaffner studied the use of mechanical explanations in biology and medicine.¹⁰ Hence, the emergence of the NMP has come mainly from two directions, one being the work of a number of philosophers of science engaged in the life sciences (biology, medicine, cognitive science, neuroscience) and the other being the growing number of studies on mechanisms and MEx in the social sciences (sociology, economics, history). This reemergence was first called “the new mechanistic philosophy” by R. Skipper and R. Millstein.¹¹

The aim of the present paper is to counter the argument that there is or should be an essential conflict between the MMP or the NMP and Christian theology—an argument which is an oversimplification at best and a deception at worst. In response to this argument, one could also claim that the NMP is theologically neutral and uninteresting. In fact, it previously seemed that there was no opening on the part of the NMP towards theology or vice versa. Recently, however, some scholars have argued that MEx can shed new light on the explanation of religion,¹² and others have noted that, if appropriately applied, it could address near-death experiences, which can be included among the vast range of phenomena grouped under the category of religious experiences.¹³ Moreover, some authors have argued that theology may benefit from analyzing the pluralism of causal explanations in contemporary philosophy of science if MEx is also to be considered.¹⁴ To make the case that the NMP could be interesting for theology, one need not exclude a confrontation between different positions, such as the NMP and Thomistic theology.

What I want to argue for is that the MMP and the NMP are not *per se* tools intended to fight religious or theological claims. The legitimacy of such a comparison rests upon the assumption—common among theologians—that the MMP and probably also the NMP are the sort of metaphysical reductionisms that are at odds with Christian theology. In the first section, in order to contextualize the subject, I will provide a brief rationale for the importance of this issue for theology, mainly discussing the vagueness of the category of the MMP and historically rooted objections to MEx. Moreover, I will formulate a distinction between methodological and metaphysical reductionism and point to the most important problems that hinder mechanistic reductionism. In the second section, I will offer counterarguments to the thesis that MEx should be read merely as some sort of metaphysical reductionism. In the third section, I will focus on two core aspects of the NMP methodology, that is, dynamic mechanistic explanation and constitutive relevance. Finally, I will offer some methodological guidance for a science-engaged theology.

It is also worth pointing out that the paper does not address the question of whether or for what reasons there has been any attempt on the part of the NMP to dialogue with theology.¹⁵ Roughly put, there are two distinct attitudes among the new mechanists that have so far been treated as being orthogonal to the theological perspective: one group (e.g. L. Darden, C. Craver, W. Bechtel and their collaborators) has been more concerned with the epistemic/methodological issues of causal theories and with methods helpful in offering satisfactory explanations; the other group (S. Glennan, P. Machamer and J. Bogen, and W. Salmon and P. Dowe if one includes them in the mechanistic wave) has spent more time attempting to develop an anti-Humean

metaphysical view about the nature of causation. Neither of these issues has been considered by the new mechanists as being linked with theological problems. The main focus of the paper is thus to assess the current stage of the NMP and identify the benefits that theology stands to gain by opening itself to NMP claims. This does not preclude the possibility that there could be (or that, to some degree, there has been, as noted above) some opening on the part of the NMP towards theology.

A Complex Tangle, and Why It Matters

Is there really a complex tangle involved if one wants to relate the MMP or the NMP to Christian theology? Given that the basic premises of the Christian theology of nature are the metaphysical primacy of God and the metaphysical dependence of the world upon God,¹⁶ this theology does not assume that only material things, measurable forces or mathematically described laws constitute reality. God is not merely a material being existing within the world. On the contrary, this theology expresses the fact that apart from the world, there is also a different sort of reality that may be described as spiritual, divine or immaterial.¹⁷ In order to analyze this complex tangle in more detail, I would like to start by highlighting two aspects: the vagueness of the category of the MMP and the distinction between methodological and metaphysical naturalism.

The Ambiguous Category of the Mechanical Philosophy

First of all, in the last three decades, various scholars have emphasized that the MMP has often been employed as a broad catch-all and that it is an extremely vague category which attempts to embrace very different enterprises in philosophy. In fact, if one compares Galileo, Descartes, Hobbes, Gassendi and Newton, for instance, one will certainly end up with very divergent models of mechanical (causal) explanation and very different ontologies. In other words, a fine-grained description of what is often uncritically called “the mechanical philosophy” (with the associated notion of “mechanical philosophers”) shows that the MMP tends to be burdened with multiple ambiguities. For instance, some scholars emphasize that this view was not primarily a rejection of Aristotelian philosophy and that it was mainly intended as a way of transforming the latter—within the mechanical framework—towards scientific (lawful) explanation of natural phenomena.¹⁸ Other scholars have underlined the fact that various magical philosophies were present in the early modern period and were involved in the early modern corpuscularianism.¹⁹ There are also those who point out that the first generation of mechanical philosophers did not identify themselves as working within the same “research program” until Boyle’s explanatory and irenic project was proposed.²⁰ Yet another group of scholars tend to emphasize that the significant differences between various versions of mechanical philosophy—that is, between the so-called voluntarists and intellectualists—were a product of differences in the underlying theological assumptions about God’s relationship to creation.²¹ Finally, many authors (e.g. D. C. Lindberg, J. H. Brooke, R. K. Merton, O. Pedersen, R. Hooykaas or I. Barbour) consider the crucial role that the Christian religion played not only in the origins of modern science but also, and in particular, in providing the social sanctions that ensured its prominence. Some scholars emphasize that the duty of scientific investigation in the modern period was in fact

enjoyed by many scientists as a religious vocation or as a duty of gratitude towards the Creator. As a consequence, practicing a mechanistic science elevated the mundane activities of the laity, that is, scientific investigation, to the special status of a vocation.²²

Today, we are much savvier from an historical point of view, and we know that we cannot apply the MMP moniker to the moderns indiscriminately. Although there was no such concept as “MMP” in the modern era, one can point to three prominent ideas associated with mechanisms: mathematization of nature, matter in motion, and the idea of mechanization of the world (*machina mundi*). Notwithstanding the current *status quaestionis*, it is still possible to find descriptions of the MMP as if it were a theoretical monolith. For instance, for E. Feser, the mechanical philosophy basically means a rejection of the Aristotelian conception of nature and of formal and final causality.²³ According to Feser, the MMP world picture—even if supplemented with theism—proved to be incoherent in contrast to the more coherent Aristotelian philosophy of nature.²⁴ In fact, one of the oversimplified interpretations of the MMP is that it was mainly a rejection of the Aristotelian philosophy. Interestingly, D. De Haan has looked for similarities and differences, albeit between the NMP and Aristotelian metaphysics, emphasizing, for instance, that the overall organization of mechanisms resembles the concept of Aristotelian form.²⁵ Although making comparisons between the NMP and Aristotelian philosophy is both very complex and risky since neither the former nor the latter (or Neo-Aristotelianism) are monoliths, I would like to emphasize the conclusion that there does not have to be a fundamental barrier, at least between the NMP and Aristotelian philosophy.

In all likelihood, the main objection to the MMP stems from the view, shared by many authors, that the modern notion of causality—in contrast to the Aristotelian one—has become very limited, and so has the ability to speak of God’s action in the world.²⁶ For instance, L. Gilkey notes that “the causal nexus in space and time which Enlightenment science and philosophy introduced into the Western mind . . . is also assumed by modern theologians and scholars.”²⁷ If God’s action is conceived of univocally as a physical force, it has to interfere with or struggle against the physical processes. In agreement with the previous claim, K. Ward points out that “the scientific world-view seems to leave no room for God to act, since everything that happens is determined by scientific laws.”²⁸ E. A. Burttt explains that since the advent of modern times, final causality has been gone: “God thus ceases to be the Supreme Good in any important sense; he is a huge mechanical inventor, whose power is appealed to merely to account for the first appearances of the atoms.”²⁹ J. Cobb further adds that “Newtonian science directed attention increasingly to efficient causes. . . . In the dominant Newtonian model of natural causality, what is caused is changed, and change is ultimately explicable in terms of local motion.”³⁰ T. Smedes echoes this idea by arguing that “because of the cultural scientism in Western society, God’s action now is limited to physical and mechanistic categories, thereby letting God compete with innerworldly physical and mechanistic causes.”³¹ K. Wegter-McNelly explains the consequences of the mechanistic approach to the conception of not only God’s action but also of human freedom:

It was physics’ characterization of the world within this new framework of mechanistic reductionism that led to a significant theological crisis in Christian thought, for if the state of the natural world was completely determined by the relevant physical laws acting

upon the prior configuration of its various parts in each preceding moment, could one still conceive of human beings as thinking and acting in the world with genuine freedom? And, equally important, could one affirm God's ongoing activity in such a world?³²

Other authors argue that there is some correlation between the development of the MMP and the origin of modern atheism.³³ This link results from the fact that a variety of materialistic philosophies in the eighteenth and nineteenth centuries (e.g. those represented by philosophers such as J. O. de La Mettrie, P. d'Holbach, D. Diderot, L. Feuerbach, K. Marx or F. Engels) were based on mechanistic materialism, which holds matter and force to be the fundamental constituents of nature and mechanics to be a fundamental scientific theory. E. Mach, well known as the philosopher who influenced Logical Positivism, was not the only vocal critic of Newtonian mechanics.³⁴ Other physicists, such as G. Kirchhoff and J. C. Maxwell, also realized that there were deep theoretical problems involved in the application of mechanical models in the domain of electromagnetism. Although research on the physics of the electromagnetic field was gaining an advantage over the previous mass/matter ontology, it was nevertheless the latter that remained widely assumed in various philosophical materialistic approaches. It seems, then, that many scholars mainly associate the MMP with this sort of mechanistic materialism to this day. I presume that since most modern theologians are not friends of the new mechanistic literature but are familiar with some standard ideas about the MMP, as previously mentioned, they may tend to think that there is or should be an essential conflict between the NMP and Christian theology.

Methodological and Metaphysical Naturalism

Although NMP and naturalism are not terms which can be used interchangeably, it seems that most new mechanists would readily accept the claim that from a methodological point of view, the only way towards explaining and predicting any phenomenon in the world is through the scientific method. At the same time, however, I am not certain whether most of them would argue from a metaphysical point of view that there are neither entities nor processes transcending the realm of what is described by modern science.

In the theology–science field, perhaps one of the greatest points of contention is the matter of whether and to what extent scientists should accept methodological naturalism and whether and to what extent the latter necessitates a commitment to metaphysical naturalism.³⁵ While T. Smith, for instance, has recently argued that “methodological naturalism does not obligate science to reject supernatural entities, but to reject supernatural methods of acquiring evidence,”³⁶ Z. Zargar and others have defended the view that methodological naturalism is underpinned by certain ontological and epistemological assumptions whose adoption necessitates commitment to metaphysical naturalism.³⁷ In opposition to the latter view, I opt for the former one, according to which methodological naturalism concerns the norms and principles that guide the scientific method and thus does not commit one to adopt metaphysical claims. To defend my position, I accept the philosophical distinction that the set of physical possibilities is a subset of the broader set of logical possibilities. If it is so,

divine action would not necessarily involve a competition between the divine and the creaturely order. Divine action would not even be considered a problem for science, because

there is the logical possibility that God acts in ways that do not break the natural order but circumvent it. Even though our conceptual apparatus may be ill-equipped to consider it (just as for most of us our conceptual apparatus is ill-equipped to think in more than three dimensions), there may be possibilities for God to act in ways that are physically or scientifically unforeseen but nevertheless logically and physically possible.³⁸

Methodological naturalism, mainly referring to the scientific method, may be defined in the following way: we explain the natural world by employing the empirical methods of science. This claim means that science investigates the world by looking for natural causes rather than supernatural ones. We explain the world by referring to the world. In other words, in scientific explanation, only the use of natural entities (mechanisms) is permitted. As regards metaphysical naturalism, it adds more to the previous claim: the *only* things that exist are those which can be investigated by the empirical methods of science. The latter is, then, a stronger thesis about the kinds of entities that exist in the world according to the current stage of scientific knowledge. The italicized part is an important qualification which suggests that no supernatural or spiritual realm transcendent to the natural world appears within our world. In other words, it suggests that the web of occurrences within our experienced world does not contain something that escapes scientific analysis (e.g. miracles, divine action, power of prayer, etc.).³⁹ Since metaphysical naturalism claims that only natural entities exist, it may prove to be incompatible with theology, which assumes the existence of supernatural entities or forces. Thus, the latter position may be expressed as a sort of metaphysical reductionism. Although the words “nature” and “naturalism” have multiple meanings,⁴⁰ the above distinction is sufficient for our further analysis.⁴¹

In view of this distinction, the MMP or the NMP seems to be a sort of methodological and metaphysical reductionist approach. While mechanistic methodological naturalism could be viewed as a commitment to a set of methods and as an explanatory tool to find out about the world, mechanistic metaphysical naturalism may be seen as a direct commitment to a picture of what exists in the world. If we look at the modern period, there was probably no single philosopher or scientist who would go as far as Descartes did in reducing life to the lifeless. Although Descartes assiduously conducted anatomies for many years and explained organisms in the same manner as engineers explained machines at the time, this does not entail that Descartes’s anatomical descriptions were nothing but a metaphysical reduction of the living to the nonliving.⁴² During that time, the notion of mechanism and the use of numerous pictures representing complex bodily organs were intended to support an understanding of their operation, which was difficult to capture in verbal propositions alone. This affinity between the concept of mechanism and anatomical images evidences the precise logic behind preparing these pictures, based on empirical evidence and partly on analogies, and having an important explanatory function.⁴³ In the modern period, the concept of mechanism has been employed not only as a metaphysical doctrine but also as a method of investigation.⁴⁴ Thus, even if the MMP or the NMP may be viewed as a sort of methodological and metaphysical reductionist approach, the two should not be conflated, and methodological naturalism should not be construed to necessitate a commitment to metaphysical naturalism.

In view of the above, is there any problem with the distinction between methodological and metaphysical naturalism? Although it is not the case that methodological

naturalists have to subscribe to causal closure (i.e. the view that any natural effect has some natural cause) nor to metaphysical naturalism,⁴⁵ what starts out as a methodological naturalism may tacitly evolve into a culturally situated *metaphysical* naturalism over time.⁴⁶ It is the historical case that the MMP served both metaphysical naturalism and atheism, especially in the various materialistic philosophies of the nineteenth and twentieth centuries. However, this was the result of a confusion of concepts and of methodological abuse rather than something intrinsically hostile to theology within the MMP. Since there is a deep relationship in human life between practice and assumptions made about reality, the distinction between explaining the natural world by the methods of science and claiming that there exist *only* the things which can be investigated by the methods of science may get and has very often got blurred over time.⁴⁷ In the next section, I will discuss in what sense MEx, as employed within the NMP, may prove to be an example of metaphysical naturalism (reductionism).

Mechanistic Metaphysical Reductionism

For my aims, it is sufficient to state that metaphysical naturalism concerns metaphysically reductionist relations between objects. Hence, the basic idea of metaphysical reduction (MR) is that if X reduces to Y , then X is nothing more than Y . At this point, the NMP seems to be particularly amenable to MR. This can be noted when one shifts from the domain of metaphysics to the crucial epistemological aspects of MEx, whereby to explain mechanistically essentially means to decompose the system into parts, specific properties and relations.

If we formulate the issue of complex mechanisms in the metaphysical terms of their parts, then we obtain the position that the mechanism is “nothing but” its parts. If various models are constructed largely by decomposing the whole, one may argue that this means being committed to two extensional claims:

Ex1: that there are basic particulars, i.e. components/parts or activities; and.

Ex2: that there are rigid references to basic particulars in mechanisms.

On the one hand, these commitments seem to bring about the sort of “compositional reductionism” which posits that mechanisms are constituted by lower-level entities and activities and that the active organization of the latter produces the phenomenon in question.⁴⁸ On the other hand, such commitments seem to bring about physicalist reductionism. Although mechanists start with the uncontroversial assumption that explanation should be causal, they are at the same time committed to physicalism, since:

the causal difference makers that explanations cite at every level of organization will also have to be physical properties. That is, in so far as there are levels of inquiry, with their own proprietary causal properties, each of these properties will differ from lower level properties of mechanisms that realize, implement, instantiate the higher-level dependency in only one way: they will have to be abstractions from lower level properties, abstractions that prescind from the details of their implementation.⁴⁹

A. Rosenberg rightly notes that purely physical difference makers with more and more details of implementation may be explanatorily irrelevant at higher-levels. This Ex1 commitment would also imply the rigid reference (Ex2), meaning that there are only singular

physical entities/properties or that mechanisms are particulars located at particular places and times.⁵⁰ Insistence on iterated componential explanation of mechanisms would cause this straightforward association of MEx with physicalism.⁵¹ Another rationale for mechanistic metaphysical reductionism could be that the analogy of machine mechanisms becomes “inappropriately endowed with the ontic status.”⁵²

For many theologians who are not familiar with the NMP, the aforementioned arguments—that is, the extensional commitments, compositional reductionism and physicalist reductionism—lead to the conclusion that there is an essential incompatibility between the mechanistic philosophy and the theological point of view. In other words, too much focus on MEx with regard to natural phenomena would entail the claim that the *only* things that exist are those which can be investigated by the methods of science and that Christian theology should therefore reject the mechanistic worldview. In fact, from an historical point of view, this was a conclusion derived not from science as such but from an oversimplified understanding of MEx. In what follows, I will argue that if one analyzes MEx, one will realize that this conclusion is too hasty since some of the premises are ill-posed and other important premises are missing. So far, I have provided a very limited picture of MEx.

Nothing but a Reductionism?

Mechanistic explanation (MEx) focuses on mechanisms conceived of as organized complex systems. The entities and activities in a mechanism are organized spatially (i.e. in terms of locations, sizes, shapes and orientations of components), temporally (in terms of the orders, rates and durations of processes) and actively (whereby specific components make a difference to other components) such that they produce a given phenomenon. Organization comes in many forms for different kinds of mechanisms, for example: spatial and temporal organization in the case of protein synthesis; homeostasis, equilibrium, feedback and self-organization in the case of the phenomena studied by complex and dynamical systems; and quantitative description of the dynamical organization of astrophysical mechanisms like supernovae.⁵³ Nevertheless, it is the active organization that distinguishes mechanisms from mere aggregates.

In aggregates, the property of the whole is simply a sum of the properties of its parts, which changes linearly with the addition or removal of parts. Parts of aggregates can be rearranged or substituted, and the whole can be decomposed or recomposed without any change to its behavior.⁵⁴ In aggregates, organization (spatial, temporal, causal) is irrelevant to the property of the whole. Conversely, mechanistic organization lies at the heart of mechanistic explanation and is defined as non-aggregative. Now, I would like to provide some remarks on the mechanistic metaphysical commitments that take this fact into account.

MEx does not seem to satisfy Ex1 and Ex2. Rather, it endorses two very different claims about mechanisms⁵⁵:

- holistic explanation (HE): there exists a *constituted* mechanism (a whole) whose parts exhibit activities that are only explicable given the behavior of the whole mechanism; and
- holistic individuation (HI): there exist mechanistic parts and activities/properties that are individuated only when they occur in some *constituted* mechanism (the whole).

MEx is not only about decomposing what is complex. On the contrary, it also focuses on the overall organization of the mechanism, that is, its constitution.

New mechanists are therefore explicitly committed not only to Ex1 and Ex 2 but also to HI and HE. The resulting metaphysical conundrum stems from the fact that pairs of sentences Ex1 and HE, and Ex2 and HI seem to be contradictory:

- HE implies negation of Ex1: since mechanisms are constituted wholes, they are not merely aggregates of parts/activities;
- HI implies negation of Ex2: since mechanistic components are mutually dependent, we are not dealing with a defined set of independent elements;
- Ex1 implies negation of HE: if mechanisms are aggregates of particulars, they are not complex wholes; and
- Ex2 implies negation of HI: mechanistic parts may be individuated independently from the occurrence of the wholes.

In other words, this metaphysical conundrum of what makes mechanisms actively organized wholes—the so-called mechanistic constitution—is the core problem of the NMP. If the answer is the active organization itself, then what makes the organization active? In their quest to find an answer to this question, new mechanists such as C. Craver, L. Darden, P. Machamer or S. Glennan focus on the productive nature of causal mechanisms.⁵⁶ At the same time, however, as in Glennan's case, they also emphasize the close relationship between activities (actual doings) and powers (capacities or dispositions not yet manifested).⁵⁷ What a mechanism does depends not only on the entities and activities (causal interactions, loops, processes, etc.) but also on how the mechanistic constituents are organized. Since the methodological aspects of mechanistic constitution are going to be discussed in the next section, I will now focus on two other consequences of the fact that mechanistic attention is drawn to the constitution: the notion of levels and the operationalization of the organization.

The first important aspect is the commitment to levels of explanation. For instance, C. Craver distinguishes three basic notions of levels: levels of science (units, products), levels of nature (causation, size) and levels of composition (material/spatial containment, mechanisms).⁵⁸ According to Craver, the notion of “levels of mechanisms” essentially refers to the last of the three, but the composition relation is not primarily understood in terms of spatial/material containment. The relata in levels of mechanisms should be understood as acting entities whereby “lower-level components are made up into higher-level components by organizing them spatially, temporally, and actively into something greater than a mere sum of the parts.”⁵⁹ The explication of mechanistic levels seems to have several conceptual benefits.⁶⁰ For instance, this understanding of levels not only corresponds to the actual investigatory practice of biology and other special sciences and distinguishes mechanisms from aggregates, but also goes contrary to the assumption that nature is in itself segregated by part–whole relations. The moral which is drawn by mechanists:

is that the choice of appropriate level of explanation is dictated by more specific and local considerations (just what it is we are trying to explain, where, as an empirical matter, the stable relationships are to be found, which details can be safely neglected as irrelevant, given what it is we want to explain and so on).⁶¹

In fact, contrary to P. Oppenheim and H. Putnam's account of levels of nature,⁶² mechanistic levels of organization are not monolithic (reductionist) divisions in the structure of the world, and multilevel MExs attempt to combine different scientific perspectives on the phenomenon to be explained. In this sense, they are neither methodologically nor metaphysically reductionist.

New mechanists mainly try to define the organization in such a way that its philosophical meaning is based on the set of operations which are conducted when investigating the constitution of mechanisms.⁶³ It is for this reason, I believe, that mechanists want to distinguish the mechanistic organization from "spooky emergence."⁶⁴ Emergence has become a term of family resemblance in current philosophical literature. In essence, it denotes a wide variety of phenomena "where new processes, interactions, entities, and properties are claimed to be observed, characteristic for higher levels of complexity of matter and irreducible to their lower-level constituents."⁶⁵ If new mechanists do not support this philosophical approach, are they suggesting, then, that all processes at the higher levels are restrained by and act in conformity to the laws of the lower levels and that explanation is not complete until micro-mechanisms have been specified? The answer is, not exactly. C. Craver argues that since mechanisms are not aggregates,

behaviors of mechanisms are sometimes emergent in this epistemic sense [i.e. of our cognitive limitations]. However, one who insists that there is no explanation for a nonrelational property of the whole in terms of the properties of its component parts-plus-organization advocates a spooky form of emergence.⁶⁶

This quote may seem to imply that new mechanists are simply rejecting the metaphysical novelty of higher-level complexity as intrinsically irreducible or the metaphysical intuition that things at the higher levels of mechanisms elicit novel causal powers/activities. In my view, however, Craver wants to avoid describing a complex organization as a phenomenon that is by definition inexplicable. Mechanists' methodological naturalism (i.e. the view according to which everything that belongs to the world of nature should in principle be investigated, tested and accounted for by methods appropriate for a science that studies the world) can be reconciled with the nonreductive metaphysical approach to mechanistic organization. In fact, from a metaphysical point of view, one may claim that the whole cannot be reduced to parts, whereas from a methodological point of view, one may argue that the complex organization should be explained by evoking, among other things, lower-level components. Since mechanisms occur in hierarchies of levels where lower-level entities and activities are components that produce higher-level phenomena, the layered structure becomes a nested hierarchical one, typically bottoming out in the lowest-level mechanisms or topping off in the highest-level mechanisms. According to new mechanists, assuming some set of entities and activities as bottom-out or top-off does not mean accepting them as being metaphysically fundamental but rather as being basic from the explanatory point of view, that is, domain specific. For instance, molecular biology does not typically regress to the quantum level to talk about the activities of chemical bonds.⁶⁷

Not all scholars are convinced that the mechanistic metaphysical picture is adequate when it comes to answering the question why certain entities enter into one kind of process or activity rather than another. C. Gillett, a prominent advocate of the research program concerning the metaphysics of realization, argues that the mechanistic talk of

entities and activities faces such a problem.⁶⁸ However, T. Polger counterargues that the metaphysical program of realization is insensitive to distinctions to which MEx is sensitive⁶⁹ and that the account of realization proves to be merely descriptive. Since it affirms that realization is a basic non-causal dependence relation among properties at different levels, it:

only affirms what the new mechanist already assumes, viz., that there is some ontological dependence relation between the properties of mechanisms and the properties of their constitutive (in the generic rather than special sense) mechanisms. It is true, on this account, that the properties of mechanisms are realized by the properties of other things. But it is not informative or explanatory.⁷⁰

New mechanists distinguish “making-up” (constitutive) relations from other types of relations since they are, on the one hand, highly sensitive to the distinction between mechanisms and aggregates, and on the other, they try to discriminate in a methodological way “how” organized mechanisms are made up. According to mechanists, the metaphysical relation (be it realization, emergence, supervenience, substantial form, etc.) only tells us “that” the higher-level entities/activities depend on the lower-level constituents, but it is indifferent when it comes to answering the question of “how” different kinds of mechanisms are made up of entities and activities in a specific case. New mechanists focus on the organization of mechanisms from the operational point of view by formulating epistemic criteria to distinguish constitutive relations. Now, I will briefly identify the criteria that help in dealing with this “how” question.

The Core Aspects of the Mechanistic Methodology

Since the NMP is deeply dependent on scientific practice, it focuses on the methodological aspects of providing good explanations. New mechanists point out that “composition and compositional explanation are a genus of which mechanistic constitution and constitutive explanation are a species.”⁷¹ Aizawa and Gillett concur with the above claim and have convincingly argued for a more pluralist account of the species of compositional explanations.⁷² To put it briefly, they divided the genus of compositional explanations into three species of explanations: analytic (in which scientists explain an individual whole using a relation to its individual parts), standing (in which scientists explain the property of the whole using a relation to the properties of its parts) and dynamic (in which scientists explain an activity/process of the whole using a relation to the activities of its parts). Although MEx integrates all these species of explanation, the last one corresponds to what is properly called the constitutive (dynamic) MEx. In fact, the latter shows that the activities of the parts are synchronous with the activities of the whole and that the activities of the parts are in some sense the same as the activities of the whole.⁷³ In contrast to causal relations where (essentially) a cause precedes an effect and is wholly distinct from that effect, compositional explanations have relations which are synchronous and which are in some sense the same. The focus on the constitutive aspects of mechanisms is the hallmark of MEx. Its roots may be found in the pioneering work by W. Salmon,⁷⁴ in which he clearly distinguished two aspects of causal mechanical explanations: the etiological aspect (looking back and revealing antecedent causes of the *explanandum*) and the constitutive aspect (looking within the *explanandum* and identifying its components and their organization).

The constitutive aspect has been addressed in a new way by Craver's account of constitutive relevance.⁷⁵ Craver's mutual manipulability account attempts to answer the question of how scientists determine whether an entity/activity is part of a mechanism by referring to experimental methods. This account formulates sufficient conditions for establishing that an activity of some entity is constitutively relevant to the mechanism responsible for a certain behavior. Whether Craver's account is successful in solving this issue has been the subject of much ongoing discussion for more than a decade.⁷⁶

What are the main methodological conclusions that emerge from the lively debate on constitutive relevance? First of all, both etiological and constitutive explanations require the notion of "relevance" to sort the things that have explanatory import from those that do not. This sorting is not a straightforward task when one is dealing with highly complex processes since relevance can easily be changed for mere correlations. Conditions for establishing constitutive relevance are primarily epistemic criteria inspired by three kinds of so-called interlevel experiments: bottom-up inhibitory experiments, bottom-up excitatory experiments and top-down excitatory experiments.⁷⁷ Secondly, the counterarguments to Craver's account were mainly based on the putative incoherence that there are causal relations between parts and wholes.⁷⁸ Apart from the overlapping of the spatiotemporal whole and spatiotemporal parts, the other contentious issue was how to precisely describe interlevel experiments.⁷⁹ Because of these two sorts of objections, Craver, Glennan and Povich proposed a revised version of the mutual manipulability account. The authors suggest that manipulability via experiments (interlevel or otherwise) may be considered as evidence for the productive continuity of mechanisms.⁸⁰ Although some of the literature on causation describes production in terms of physical processes,⁸¹ the authors hope that further developments in their new account will provide the resources needed to understand productivity as the relation holding between higher-level phenomena in various domains.

One could object that, in any case, Craver, Glennan and Povich's revision of the mutual manipulability account is parasitizing on the reductionist physicalist assumption or, in other words, that their making sense of productive continuity leads to a flat metaphysics of physical processes and does not answer why certain individuals enter into this kind of activity rather than another. However, a key lesson from the mechanistic debate on constitutive relevance is that new mechanists approach the constitution of mechanisms, above all, from the epistemic point of view by formulating criteria to sort out the relevant constitutive relations. This ambition is driven in part by the conviction that one who knows the antecedent causes and constitutive mechanisms of the phenomena to be explained "knows the buttons and levers one must know to bring the phenomena under our control."⁸² The mechanistic project builds a picture of what the world is like (metaphysical commitment), but it is bounded by the search for how it can be efficiently discovered (epistemological commitment). This is probably the reason why some may find this sort of philosophy very limited in the description of reality, since it is based on the "the science for manipulation."⁸³

Proposals for Theology

With respect to mechanistic philosophy, one can imagine a wide range of theological proposals: from those that challenge this type of philosophy and attempt to separate or defeat it to those that interact with it in various ways. From an historical point of view, the

second option seems to have been dominant in the modern period. The mechanistic world picture was developed within the context of European Christian culture where theologians and philosophers of nature (scientists) were engaged in lively debates on how to do science and how to understand what science reveals about the world.⁸⁴ In the centuries that followed, however, the first option—that is, the conviction that the mechanistic and theological worldviews are mutually exclusive—seems to have become predominant. Although I have countered the argument that mechanistic philosophy is nothing-but metaphysical reductionism, my proposal for theology is not one of concordism.⁸⁵ If the differences between the two views should not be blurred, what can be done instead? In response to this question, I would like to outline two alternative paths for a science-engaged theology: from metaphysical naturalism to a theology of nature and from methodological naturalism to a theology of science.

Although it is implicitly asserted by new mechanists that nature and natural processes are the only reality (to the exclusion of supramundane realities), theologians may nevertheless benefit from knowing what science—as seen through the mechanistic lens—reveals about the causal structure of the world. For instance, the mechanistic debate on the constitutive aspects of mechanisms shows how complex the processes studied by particular sciences are and how difficult it is to discover and correctly describe their inner structure. A theology of nature comes with its own dogmatic tradition and interprets the world from that point of view. At the same time, such a theology should take into account the findings of science when it considers the relation of God to the world, since it is science that provides us with our actual worldview. While it is true that metaphysical naturalism (as present within the NMP) does not argue against the existence of God, the broader perspective of theology (which looks at reality *sub ratione Dei*) may appeal to the order, inner organization and complexity of natural processes as signs of God the Creator.⁸⁶ It is not my argument that familiarity with the NMP is a prerequisite for pursuing a theology of nature. Nevertheless, I suggest that labeling the mechanistic project as being merely reductionist (without further distinction) and thus, by definition, contradictory to theological claims reveals the theoretical emptiness of such a theology of nature and its inability to engage in discussion. In other words, theological interest in the metaphysical and epistemological issues present within the NMP could be sufficient and beneficial when it comes to providing a theological interpretation of nature.

The second option, pertaining specifically to a theology of science, is to take advantage of methodological naturalism, which assumes—with regard to the method of science—that science explains the world by evoking it. The kind of theology of science to which I am referring here was proposed by Michał Heller.⁸⁷ According to Heller, this theology of science, as a theological subdiscipline, should be concerned with the very existence of science, the conditions of scientific knowledge, and science as a value.⁸⁸ The theology of science is thus a branch of theology that not only engages with the empirical sciences but also analyzes their foundations, methods and results from the perspective of the fact that these sciences study the world created by God. On the one hand, the basic premise of the theology of science is the statement that the world has been created by God. On the other hand, as Heller explains,

with the theology of creation comes another problem—the problem of the rationality of the world. What I mean by rationality of the world is that property of the world by which it can

be studied rationally. This investigation of the world belongs to the domain of science, and the accomplishments within the sciences are the best testimony to the rationality of the world. From a theological perspective, the rationality of the world is the mark of the Creator's rationality.⁸⁹

This investigation of the ordered character of the world is crucial to the theology of science. Although I have mainly focused on the empirically grounded commitment to naturalistic causes and explanations, my extensive analysis of MEx and its methodological or metaphysical commitments has been aimed at demonstrating that while analyzing the proper methods and results of the sciences, the theology of science may better grasp the fact that empirical sciences are, in a sense, a rational attempt to explain the order of the natural world.

While modern philosophy could be seen to treat the dichotomy between subject and object as a guiding epistemological principle, modern science and the application of MEx have shown the importance of scientific research (e.g. formulation of hypotheses, formal reasoning, modeling of phenomena, etc.) in understanding the world. As a consequence, the relationship between humans and the world has become mediated by scientific knowledge, with the subject playing a decisive role, although exposed to doubt and uncertainty. Therefore, science becomes the bearer of a new way of looking at the world. This new way is deeply bound by our theories, mechanistic models and scientific concepts. It is in this context that a more articulated theological survey of the problem of rationality of the world, as noted by Heller, can be made. In fact, my analysis of the NMP shows that the interaction between epistemology and ontology (which is not about what actually exists but about what is assumed according to certain theories or models) is something typical of the contemporary philosophy of science. If the organization of a mechanism is the *explanandum*, the explanation is built on the domain of conceptual (philosophical) issues and on that of theory-laden empirical data. This combination of epistemological and ontological aspects made the philosophy of science in the second half of the twentieth century recognize that rationality is always expressed contextually. What remains for a theology of science here? Theologians might be interested not so much in the specific way in which a phenomenon is described, explained, modeled, etc. as in the fact that nature itself is revealed to some degree as being rational or intelligible.⁹⁰ While the proper task for a theologian is not to introduce divine intervention into physical and biological processes among entities and activities, the existence of an intelligible world in itself needs an explanation (which does not have to be restricted to chains of natural causes). The intelligibility of the world is not the result of scientists' efforts but a condition offered to them to enable them to discover how the *machina mundi* is working.

Conclusions

There are various models that describe the historically complex relationship between science and religion, and within this plurality, only a small subclass refers to conflict narratives.⁹¹ The thesis that there exists an essential conflict between the MMP or the NMP and Christian theology is an oversimplification at best and a deception at worst. The MMP and the NMP are not in themselves tools intended to fight theology. It is true, from an historical point of view, that worldview statements based on arbitrarily selected elements of the scientific method, later ambiguously labeled as the mechanistic philosophy, were

directed against some aspects of the Christian religion or theology. Moreover, also true from an historical point of view, while science seeks only a natural meaning in an area which has so far been perceived as religious or theological, religion or theology may begin to oppose such methodological naturalism if it seems to be employed as a metaphysical one. Nonetheless, it is not a “historical necessity” that the employment of MEx has led or is leading to a clash between the MMP or the NMP and theology.

The profound change in the philosophical landscape that took place in the wake of the unrealized ambitions of logical positivism in the first half of the twentieth century has demonstrated that the philosophical problems which stem directly from the pluralism of sciences and their methods may pave the way for a very fruitful dialogue between science, philosophy and even theology. From this perspective, I have tried to argue that the NMP should not be labeled *a priori* as something hostile to theology. On the contrary, since MEx mainly focuses on the epistemological aspects of explaining natural phenomena, it does not have any pretense to the universal character of metaphysical claims when it comes to its articulation. A theology of science capable of critically assessing the main aspects of MEx may be beneficial in developing a theological reflection upon nature, even in such a case. I intend to provide a comparison of the MMP and the NMP and to answer the question of whether and to what extent the NMP is new in a separate paper.

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Acknowledgment

This research was funded by the National Science Center, Poland, 2021/41/N/HS1/01338. For the purpose of Open Access, the author has applied a CC-BY public copyright license to any Author Accepted Manuscript version arising from this submission.

Many thanks to Paweł Polak and Jacek Rodzeń and to the two anonymous reviewers who have read the manuscript and suggested valuable improvements.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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