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A Nascent Realist Theory of the Laws of Nature Based on the Doctrine of "Motion in Substance" from Late Islamic Philosophy

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Abstract

This paper proposes a distinct realist perspective on the laws of nature, rooted in the tradition of late Islamic philosophy, which may offer a new solution to one of the difficult challenges of scientific realism, termed the 'Central Dilemma' by Mumford. It begins with a brief introduction to the problem of scientific realism concerning the concept of the laws of nature. Then, in the first part, we compare the realist theories of the laws of nature developed by Lewis, Armstrong, and Bird, focusing on their account of the three key concepts of causation, necessity, and law. Based on this analysis, the second part formulates a new realist theory, drawing from the doctrine of "Motion in Substance" from Late Islamic Philosophy, particularly the philosophical thought of Tabatabai. This will be done by extending the idea of motion in substance and examining some of its implications. This new account is, in some respects, similar to Bird's view, yet in other respects Humean and similar to Lewis's. By comparing this new approach with the aforementioned three theories, concerning their accounts of causation, necessity, and law in relation to the 'Central Dilemma' challenge, we conclude that it could bring a new vision that could potentially resolve this challenge.

Original Research

Keywords

laws of nature, central dilemma, necessity, causation, motion in substance.

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Introduction

The term "laws of nature" is not mentioned directly in pre-modern Islamic works on philosophy, whereas in contemporary philosophy it is virtually ubiquitous, being the focus of study in the philosophy of science, philosophy of mind, philosophy of religion, and elsewhere. In contemporary philosophical literature, the terms "law of nature" and "scientific law" are closely interrelated; for the purposes of this paper, the former is treated as synonymous with an ideal definition of the latter. The potential candidates for laws of nature are well-established scientific theories, that is to say, those which have a strong record in predicting and explaining natural events (Mittelstaedt & Weingartner, 2005, pp. 11–12).

Accounts of the laws of nature fall into one of two opposing camps, realist vs. antirealist. Most contemporary philosophers maintain a realist approach to scientific laws, arguing that our best-confirmed scientific laws generally succeed in describing reality (Carroll, 2016, Section 5). The realist stance is also the one we prefer in this paper. For us, scientific realism refers to the belief that the goal of science is to convey a truthful (as opposed to, for example, empirically adequate) image of the world.

Issues of scientific realism arise at two levels. The first level concerns the relationship between scientific theories (models) and perceived entities. The primary question at this level is whether we have reason to believe that scientific explanations (formulations) provide a truthful representation of directly observed or detected entities. The second level addresses the nature of laws of nature, questioning whether these laws, as propositions or any other mental entities, have real entities outside that serve as their objective references (Ghins, 2024, pp. 41–42). In this paper, we align with recent decades' debates and focus on the latter issue.

Are there real laws that 'govern' nature or not? This initial question pertains to 'Realism about Laws of Nature' (RLN) and traces back to Armstrong's formulation (Armstrong, 1985, p. 106). However, as Mumford mentions, it may be misused or misunderstood in a strong manner.

Mumford attempts to use the term 'governing' in 'as loose a sense as possible' while still conveying something meaningful. He maintains that any nomological realist must acknowledge that laws 'play a role.' To justify belief in RLN, laws must contribute something to nature such that the world would be significantly different without them. The realist approach towards laws posits that from 'properties plus laws,' events or causal roles could be realized, whereas without the laws, the world would be entirely different (Mumford, 2004, pp. 145–146). It is

meaningless being a realist about laws while accepting that laws do not play an original role, or that their role could be reduced to other ontological entities.

Based on this point about RLN, Mumford formulates the 'Central Dilemma.' This dilemma posits that if there is a governing or determining role for laws, then such laws are either a) external to the entities they govern or determine, or b) internal to them. Mumford argues that both of these approaches are dead ends. Externalists, such as Armstrong, face difficulties in explaining the relationship between laws and other ontological entities (e.g., properties) and entail an incredible thesis (Quidditism). On the other hand, internalists, such as Ellis, reduce laws to other ontological entities, thereby failing to preserve their original role, and so abandons RLN. Regarding this dilemma, Mumford defends a lawlessness metaphysics (Mumford, 2004, pp. 160–176).[1]

We try to evaluate this challenge, that is, the Central Dilemma, from the perspective of Late Islamic Philosophy. In the first part of this paper, we offer a comparative account of standard realist theories of the laws of nature and explain more about their relationship with this challenge. We employ the results of the first part as a conceptual framework for the second.

The second part of the paper adopts another perspective, in line with the increased interest in recent decades in the history of Islamic philosophy, seeking to determine what philosophers from the Islamic tradition *can* contribute to the understanding of laws of nature. We focus on the works of Seyyed Mohammad Hossein Tabatabai (1904-1981) and his follower Seyyed Hossein Nasr.

Tabatabai is regarded as the central contemporary figure of Islamic philosophy, a tradition which has survived without interruption within Shiʿi Iranian circles down to the modern period. Modern philosophers with an interest in Islamic philosophy will know of Tabatabai's thought at least via the works of two of his followers, Nasr and Corbin, published in the second half of the twentieth century (El-Rouayheb & Schmidtke, 2017, pp. 2–3; see also Rizvi & Bdaiwi, n.d., pp. 654–75). He was a highly regarded expert in Islamic philosophy in contemporary Iran, and his two textbooks, *Bidayat al-Hikmah* and *Nihayat al-Hikmah*, are required reading in the Shiʿi seminaries for those who are interested in philosophy. Both of these books are highly mentioned in this paper.

So, it seems that the development of a new realist theory of laws of

1 Ellis clearly acknowledges this analysis of his own view 'Essentialism' in (French, 2006, pp. 337–341).

nature from an underappreciated scholar from the Islamic tradition would be a welcome addition to the contemporary literature.

Laws of nature: A comparative study of the classic theories in relation to the 'Central Dilemma'

Approaches to the laws of nature can be categorized into three principal camps:

- **The Ramsey-Lewis Humean view**: This perspective posits that laws of nature are generalizations of concrete regularities, which appear as true propositions within an axiomatic system of the sciences.
- **The Tooley-Armstrong anti-Humean approach**: This approach suggests that laws are essential relations between universals, but their truth need not be metaphysically necessary.
- **The Neo-Aristotelian position**: Developed by Ellis and Bird, this view attributes metaphysical necessity to the laws of nature.

Hence, there is a fundamental difference between these groups in their responses to this question: "Are nomic facts based on non-nomic facts?" (Beebee, 2000, pp. 571–572). In the following and based on a brief overview of each approach, I aim to formulate the basic answer of these perspectives to the 'Central Dilemma' challenge, focusing on the three components: 'Laws of Nature', 'Causality', and 'Necessity'.

Lewis's view: regularities of Humean properties

Lewis holds that in the case of laws of nature, we are dealing only with sequences of the properties of facts and physical objects. It is simply the differences in the sequencing and order of physical properties that form the ontological basis for all beings (Lewis, 1986b, p. ix). Indeed, Lewis's ontological project draws on the relation of Humean *supervenience*, which correlates with Hume's view on nomic concepts and physicalism:

> Call a property "Humean" if its instantiation requires no more than a spatiotemporal point and its instantiation at that point has no metaphysical implications concerning the instantiations of fundamental properties elsewhere and elsewhen. (Loewer, 1996, p. 102)
>
> A dot-matrix picture has global properties – it is symmetrical, it is cluttered, and whatnot – and yet all there is to the picture

> is dots and non-dots at each point of the matrix. The global properties are nothing but patterns in the dots. They supervene: No two pictures could differ in their global properties without differing, somewhere, in whether there is or isn't a dot. (Lewis, 1986a, p. 14)

From this ontological point of view, therefore, notions such as causation and necessity do not correspond to independent ontological entities. They are indeed contingent on the manifestations of Humean properties. In other words, the basic units of our ontology are limited to Humean properties. Laws of nature, being the next concept of this ontological analysis, in some sense originate from regularities and uniformities among the Humean properties.

This approach towards laws of nature had its genesis in 1928, when Ramsey briefly remarked that if we knew everything, we should systematize our knowledge as a deductive system and that the general axioms in that system would be the fundamental laws of nature (Ramsey, 1990, p. 143). In this view, accepted and later developed by Lewis, the laws of nature are propositions that express generalizations emerging from such a logical deductive system.

In Lewis's view, deductive systems are "collections of truths, not individual truths," which are evaluated by the criteria of simplicity and strength. Laws of nature are generalizations within this system, and thus not every truth in the winning collection corresponds to a law. "So even if the best system includes particular facts about the Big Bang or its immediate aftermath […]," these facts would not count as laws of nature on Lewis's view (Weatherson, 2016).

Lewis uses this Humean approach to the laws of nature (L-Laws, in Loewer's term), to explain two other interconnected metaphysical concepts, causation and necessity. In Loewer's summary:

> A proposition is L-physically necessary just in case it is true in every world compatible with the L-laws. L-physical necessity thus defined is less than metaphysical necessity, more than mere actuality (not every truth is physically necessary), but thoroughly grounded in actuality. (Loewer, 1996, pp. 106–107)

Lewis explains causation via the use of counterfactuals. The counterfactual $A \rightarrow B$ is true in a possible world if and only if any possible world wherein A and B are both true is more *similar* (or closer) to the first possible world as compared to any possible world wherein

A is true and B is false.

Similarity is assessed based on the compliance of this possible world in terms of particular events and the compliance of its spatiotemporal status with *what the laws of the first world predict.* Consider, for example, the counterfactual 'If Vladimir Putin had pressed the nuclear attack button at midnight on January 1, 2024, a nuclear explosion would have happened in Europe." This conditional statement is true in the actual world. Now consider a possible world at a time before midnight of January 1, 2024, with the only difference being a minor neuronal event in Putin's brain:

1. **Hypothesis 1:** If a nuclear explosion happens in Europe when the nuclear attack button is pressed in the possible world, then the spatiotemporal regions of this world comply with the physical laws of the actual world.

2. **Hypothesis 2:** If a nuclear explosion does not happen in Europe when the nuclear attack button is pressed in the possible world, then the spatiotemporal regions of this world are extremely noncompliant with the laws of the actual world.

Hence, the similarity between the possible world and the actual world is greater in the former than the latter. In this regard, Loewer explains Lewis's conception of causation (what Loewer calls L-Causation) as follows:

> Event e L-causally depends on event c just in case c and e are distinct occurring events and if c had not occurred, e would not have occurred (or the chance of e would have been smaller). Event c L-causes event e just in case there is a chain of events c … e related by causal dependence. Of course, Lewis claims that L-causation is causation. (Loewer, 1996, p. 107)

This triad, the L-Laws, L-Necessity, and L-Causation, as mentioned above, are the three key parts of the Humean metaphysical framework, formulated by Loewer according to the Ramsey–Lewis view, or the so-called L-Theory.

Although Mumford refers to Lewis's approach in defense of a lawless metaphysics, the formulation of L-Theory by Loewer suggests that we could categorize the Ramsey-Lewis approach as RLN. Mumford's main criterion, which demands an original 'role' for laws of nature, appears to be satisfied by L-Theory, at least as formulated by Loewer. This role is rooted in the 'predictions' that laws suggest when comparing two possible

worlds based on their compliance with spatiotemporal statuses. According to Loewer, the compliance of spatiotemporal statuses between two possible worlds is explained not just by mere Humean properties but *also* by the *similarities* rooted in their laws of nature.

We can encounter this formulation of the Humean approach toward laws of nature, that is, L-Theory, with the Central Dilemma challenge. Mumford asks, "How could something govern, or play a governing role in, that upon which it supervened?" (Mumford, 2004, p. 155). It seems that the answer depends on how strictly we interpret the question phrase 'How.'

If 'How' is used to ask a weak question about *a necessary condition* for explaining the ontological relation between laws and properties (or any other modal entities in general) which is not a reductionistic explanation (to avoid the second horn of the Central Dilemma (Mumford, 2004, pp. 153–156)), then the following answer is appropriate:

- Consider two possible worlds, W1 and W2, and their laws, L1 and L2, which supervene on their properties, P1 and P2. Supervenience means:
  - In each possible world W, if we have P, then we have L.
  - Between two possible worlds, W1 and W2, it is possible that P1 and P2 are identical but L1 and L2 are different.
  - If W1 and W2 are similar, then P1 and P2, and also L1 and L2, *must* be similar.

Thus, regarding L-Theory, the original role that laws could play is making two possible worlds more similar, and laws *could not be reduced to other entities*. This explanation is sufficient to rescue L-Theory from the Central Dilemma, because it shows that L-Theory is neither an externalist view about the laws of nature nor reductionist. However, if the 'How' question carries a strong ontological significance, necessitating a comprehensive explanation of all metaphysical aspects – such as inquiries into the identities of properties and challenges related to quidditism, which may be acknowledged by Humeans – then additional effort is required.

Armstrong's view: necessary relations between universals

There is a distinct difference between the Ramsey–Lewis and Tooley–Armstrong views concerning the independent reality of the laws of nature. As Armstrong says:

> It is my conviction that the laws of nature exist in independence of the human minds which seek to formulate them. I am a Realist

> about the laws of nature. The Regularity theory of the laws of nature begins as a Realist theory, although under intellectual pressure it often moves in an anti-Realist direction. […] it is fairly clear that: (1) It is a law that Fs are Gs cannot be reduced to: (2) Each F is a G. […] If (2), or somewhat more sophisticated versions of (2), fail as a Realist analysis of (1), then it is natural to consider strengthening the modality of (2), either by: (3) It is physically necessary that each F is a G or (4) It is logically necessary that each F is a G where (3) is a contingent necessity, stronger than (2) but weaker than (4). I myself favor (3) rather than (4), but the point which I want to make here is that to countenance either (3) or (4), in a form which will mark an advance on (2), involves one in recognizing the reality of universals. (Armstrong, 1982, p. 7)

Based on the above quotation, Armstrong holds an anti-reductionist view of the laws of nature, where reductionists believe that the laws of nature are rooted in non-nomic facts, that is, Humean properties. Armstrong's theory, hereafter A-Theory, was advanced in the late 1970s as a rival to Humean views, especially the Ramsey–Lewis version. In A-Theory, the laws of nature are necessary relations between Universals. Based on Armstrong's criticisms of the Ramsey–Lewis view, he assigns necessity an *ontological reality* as a relation between universals, understood as more than a mere collection of necessitations, each holding in an individual case.

This would be true if we presuppose that "there is something the same, or similar, in each case of the Fs, and something the same, or similar, in each case of the Gs." Consequently, by the mentioned presumption, we could explain the particular necessitations in virtue of a relationship between the two "samenesses" or "similarities" between Fs and Gs: "Being an F necessitates being a G and, because of this, each individual F must be a G" (Armstrong, 1982, p. 8).

In fact, since being an F necessarily requires being a G, then all Fs are Gs. At the basis of Armstrong's theory, we therefore find the posited existence of concrete causation between universals, that is, causation between types instead of tokens, and thus that "token causation" is founded on this "type causation":

> We have the bunch of singular causations, the same sort of cause bringing about the same sort of effect. May we not seek to explain this? May we not hypothesize that this uniformity

> holds because something's being F brings it about that that same something becomes G? This latter is not a "general fact," one expressed by a universally quantified proposition. Rather it is supposed to be an "atomic fact," albeit a higher-order fact, a relation between the universals F and G. […] the required relation is the causal relation, the very same relation that is actually experienced in the experience of singular causal relations, now hypothesized to relate types not tokens. (Armstrong, 1993, p. 422)

So in this metaphysical framework, A-Causation, being a necessary relation between universals, cannot be reduced to anything else. In other words, Armstrong considers A-Causation to be an A-Necessary relation between universals, and thus a basic metaphysical-ontological entity. Thus, A-Laws are not considered to be general propositions; rather, some propositions refer to these real necessary relations obtaining between universals.

Mumford demonstrates that A-Theory cannot resolve the central dilemma challenge and ultimately succumbs to the first horn of the dilemma. He argues that if laws and the entities they govern are considered independent existences, there appears to be no restriction preventing their independent variation. Consequently, it is conceivable that different laws could govern the actual properties, or that the actual laws could govern a different set of properties (Mumford 2004, p. 84). As Mumford notes, this perspective is explicitly endorsed in Armstrong's combinatorial theory of possibility (Armstrong, 1989, 2004).

This means that, for instance, if property F might be involved in various laws, such as N(F,G), N(F,H), N(F,I), …, N(F,X), then the externalist approach posits that F does not necessarily have to be involved in any of these laws. F would retain its identity even in the absence of these laws or if it were involved in a different set of laws, such as N(F,G*), N(F,H*), N(F,I*), …, N(F,X*) (Mumford, 2004, p. 150). But then, the notion that the identities of properties are primitive appears unnecessary. Consider whether properties F and G could exchange their nomological roles while retaining their identities as F and G. If F were to assume all the nomic connections of G, and G were to assume all the nomic connections of F, what would prevent F from becoming G and G from becoming F?! This is the contradiction that A-Theory faces when faced with the central dilemma. An answer to this issue is provided by 'Quidditism,' as proposed by Black (Black, 2000, p. 92). However, it is a Humean answer and is not suitable for proponents of the A-Theory.

Bird's view: metaphysical ncessary relations between particular essences

In the A-Theory, as Bird critically remarks, necessity is a theoretical concept that we arrive at logically through analyzing causation. But in Bird's view, which we may call B-Theory, necessity is prior to causation: In other words, necessity is an original fact in our world which cannot be reduced to other entities. In this view, the essence of objects must be taken seriously, and the necessity relation holds between particular dispositions, rather than between universals.

Bird holds that the ontological component of a law in the A-Theory is "a second-order relation between first-order universals," a relation which is given the name of "nomic necessitation." As Bird shows, when this relation holds between two universals, it entails the corresponding generalization $N(F,G) \Rightarrow \forall_x(F_x \rightarrow G_x)$ but not $\forall_x(F_x \rightarrow G_x) \Rightarrow N(F,G)$[1] (Bird, 2005, p. 355). That is why Bird says:

> The problem facing this view is telling us more about what N is. For all we have been told so far, N cannot be distinguished from that relation which holds between F and G when $\forall_x(F_x \rightarrow G_x)$ is deducible from the strongest, simplest axiomatic systematization of the facts [i.e., L-Theory]. Tooley tries to avoid this problem by making N irreducibly second order and by taking "N" to be a theoretical concept. We hypothesize the existence of N (and related second-order universals) to explain the existence of the regularities we see around us. This seems odd. Certainly, we hypothesize the existence of particular laws to explain particular regularities and patterns. Doing so presupposes the existence of laws in general and the capacity of laws to explain. But Tooley proposes that we hypothesize the existence of lawhood in general to explain the existence of regularities in general. The oddity is explicated thus. (Bird 2005, 356)

In this regard, Bird appeals to the notion of *dispositions* to account for the metaphysical necessity of the laws of nature. Dispositions are internal and essential properties, and are invariant across all possible worlds. In this view, the origin of what is seen as laws or regularities in nature goes back to the intrinsic and essential properties of objects, and therefore those objects have the same attributes in all possible worlds: hence, as a result the laws of nature will be the same in all possible

1. Where "⇒" symbolizes entailment.

worlds (Bird, 2009, p. 44). This view sees the source of law in the essence of things. Bird thinks of dispositions as things that act in nature, based on the necessary relationship between stimulus and manifestation, and believes that such a relationship can be expressed in the following fundamental proposition (Bird, 2005, pp. 353–354):

$$\mathrm{D}x \leftrightarrow Sx \Box\!\!\rightarrow \mathrm{M}x$$

This relation, which is a conditional analysis of dispositions, means that object x has a disposition D if and only if S stimulates x, x necessarily manifests behavior M. Laws of nature, being based on this relation, can be expressed as a general conditional proposition as follows (Bird, 2005, p. 355):

$$(\forall x)((Dx\&Sx) \rightarrow Mx)$$

For Bird, since a disposition is essential for an object, the above relation indicates that a law of nature is metaphysically necessary. He argues by *reductio ad absurdum* to show that in worlds where specific substances, such as salt and water, do exist, related laws hold too. He supposes a world in which there is a failure of salt to dissolve in water, so that in this world, Coulomb's law (as a law pertaining to that dissolving) is false. But due to his analysis of laws of nature as formulated above, since laws are rooted in dispositions, and as we may suppose that there is both salt and water in this world, Coulomb's law *must be upheld*. "So this world is one in which Coulomb's law is both true and false. Hence, there is no such world, and the assumption that it is contingent that salt dissolves in water is refuted" (Bird, 2001, pp. 270–271).

Thus, the B-Law statement "salt dissolves in water," which is a synthetic statement, is regarded as metaphysically necessary. In this metaphysical framework, causation, that is, B-Causation, is explained by particular metaphysically necessary facts governing stimuli and manifestations concerning the dispositions of substances. Hence, substances are basic ontological entities in every possible world, which are defined and detected by their dispositional essentials. For Bird, causation is a metaphysically necessary relation between particular substances, a modality we may refer to as B-Necessity. In this respect, B-Theory says that B-Laws are generalized propositions proposed by scientists to describe metaphysically necessary relations between particular substances obtained due to their essential dispositions.

B-Laws, B-Necessity, and B-Causation, as explained above, are key elements of a Neo-Aristotelian metaphysical framework which we call

"B-Theory." As it has been formulated here, B-Theory requires us to accept the existence of particular substances with essential dispositions as ontological basic entities in all possible worlds.

Mumford, referring to the second horn of the central dilemma, raises the question of how something could govern or determine that to which it is reducible. How could something govern or determine that by which it is constituted? For example, the law that ravens are black, as discussed by Lowe, cannot make ravens black if the law is merely reducible to blackness being a characteristic of ravens. The law states that blackness is a characteristic of ravens, but cannot enforce this characteristic. If laws are reducible, they seem to lack any further governing power (Mumford, 2004, pp. 155–156).

Although Ellis, an essentialist criticized by Mumford, somehow acknowledges Mumford's objections and calls some of his own statements about laws governing as tongue-in-cheek; that is, he abandons the claim of realism about laws (French, 2006, pp. 438–439), but Bird defends realism about laws and tries to give an answer to Mumford's view. Bird's defense of realism about laws involves two key steps. First, he critiques Mumford's stringent interpretation of 'governing,' arguing that explanations can also be considered a form of governance, thereby challenging Mumford's rigid criterion. In the second step, Bird draws on scientific laws, presenting them as evidence to support the notion that laws are real entities (French, 2006, pp. 443-447, 450-453).

Faced with the central dilemma, Bird addresses Mumford's question regarding how something internal can govern over it by modifying the meaning of the governing of laws. Bird then argues that laws are internal to dispositions but do not govern them directly. Instead, laws govern particulars, specifically the possession, acquisition, and loss of properties by these particulars (French, 2006, p. 448).

Bird's defense of realism about laws of nature is robust, but shifting properties with particulars does not seem to resolve the central dilemma. This is particularly evident in Bird's metaphysics, where properties, that is, dispositions, are internal to particulars. From Mumford's perspective, laws are also internal to particulars, thus raising the main question again: how can something govern or determine that to which it is reducible?

Comparing realist theories of laws of nature concerning their key concepts

By way of comparative analysis, we can now recapitulate what was said

about laws of nature in the course of our assessment of the three key concepts, Law, Necessity, and Causation. In this context, we aim to articulate Tabatabai's perspective on the laws of nature and examine its relation to the central dilemma.

As previously mentioned, in L-Theory, laws supervene on particular properties, facts, or states of affairs, meaning they are not reducible to them. L-Theory employs similarity and prediction in possible worlds to connect laws to reality. To explain causation and necessity, it utilizes two logical concepts: counterfactuals and possible worlds. From an ontological perspective, L-Theory posits only Humean properties, with laws supervening on them. However, L-Theory requires further elaboration to fully explain its ontology, as supervenience is a minimal concept that provides merely a logical definition rather than an ontological one.

In contrast, A-Theory posits that universals and the necessary relations between them are ontologically independent of particulars. These entities are neither Humean nor supervenient on Humean properties. Instead, A-Theory asserts that causation, as observed in nature, necessitates the acceptance of necessary relations between universals. Universals function as predicates in law-expressing propositions, thereby ensuring their truth. Consequently, in A-Theory, necessity and causation possess ontological reality and govern the world. Laws, articulated as general propositions, refer to real necessary causal relations between entities, which are manifestations of necessary relations between universals in individual instances. However, as previously demonstrated, A-Theory fails to address the first horn of the central dilemma, which requires an explanation of the identity of particulars.

Rather than universals, meanwhile, B-Theory appeals to dispositions in order to make necessity metaphysical. Things have dispositions, and because of them, there are necessary relations between stimuli and manifestations, which are expressed as general conditional statements that are indeed laws. Causation, finally, can only be seen in particular metaphysically necessary facts referring to stimuli and manifestations as they concern the dispositions of things. However, as previously discussed, B-Theory encounters the second horn of the central dilemma when questioned about how something can play an original role in relation to which it is reducible.

The table below summarizes this comparison. Numbers refer to the modal priority of the logical concepts in each theory consecutively:

Table 1 Comparative Analysis of Realist Theories about Laws of Nature in Summary

Theories and Their Respective Ontology		Law	Necessity	Causation	Faced with the central dilemma
L-Theory	Modal Priority	I	II		Needs more to overcome the central dilemma challenge.
	Humean Properties + Supervenience	Laws supervene on particular properties, facts, or states of affairs, meaning they are not reducible to them, and similarity and prediction in possible worlds show they are rooted in reality.	Causation and necessity are patterns that could be detected by our logical analysis of counterfactuals and states of affairs in possible worlds.		
A-Theory	Modal Priority	II	I		Could not overcome the first horn of the central

Theories and Their Respective Ontology		Law	Necessity	Causation	Faced with the central dilemma
	Universals + Necessary Relations between them	Laws are general statements that refer to necessary relations between universals. Conformity of general law statements with the necessary relations between universals guarantees the truth of law statements.	Necessity (which we find when we analyze particular causal relations in the world) and causation have an ontological reality and govern the world through real relations obtained between universals.		dilemma challenge.
B-Theory	Modal Priority	III	I	II	Could not overcome the second horn of the central dilemma challenge.
	Dispositions + Necessary Relations because of them	The general conditional statements are laws.	There are metaphysically necessary relations between dispositions, which could be expressed as general conditional statements.	Causation is a metaphysically necessary relation between stimuli and manifestations in particular events due to the dispositions of particular things.	

Late Islamic philosophers' metaphysics: reconstructing their contributions on the laws of nature

We now turn to formulate Tabatabai's views about laws of nature by referring to some of his metaphysical thoughts.

Late Islamic philosophers set aside the Aristotelian paradigm

One of Tabatabai's contributions to Late Islamic Philosophy is to have drawn upon "the Sadrian notion of motion in substance and the dynamic of the universe to connect traditional Islamic philosophy with new developments in cosmology" (Rizvi & Bdaiwi, n.d., p. 655). This would be used as the basis for approaching the main goal of this paper: to formulate a new realist theory, drawing from the doctrine of "Motion in Substance" from Late Islamic Philosophy. But before probing the analysis of what we may call the T-laws, T-necessity, and T-causation that underlie Tabatabai's thoughts about laws of nature, we should first clarify the basic metaphysical principles of Late Islamic Philosophy.

Late Islamic Philosophy, which is also called 'The Transcendent Philosophy' due to the Mulla Sadra's (ca. 1571–1636) book name *The Transcendent Philosophy of the Four Journeys of the Intellect, is a realistic tradition often described as a metaphysical revolution in the history of Islamic thought, especially because of its doctrine of Wujud (existence).* There are two famous principles that make an important shift from Aristotelian Metaphysics: asalat al-wujud and tashkik al-wujud.

The first principle is *the ontological primacy of existence over quiddity (essence) in contingent beings* (asalat al-wujud). This principle could be understood as the answer to a question asked by late Islamic philosophers: Granted that there is a distinction between the concepts of *existence* and *quiddity*, which of these concepts is real, in the sense of corresponding to what is real in the concrete object that exists in the external world (Nasr, 1989, 424)? The quotation below is a sample of Tabatabai's answer to this question:

> A proof of it [the ontological primacy of existence] is that quiddity as such is indifferent to [or stands in equal relation to] existence and non-existence, and were it capable by itself of emerging from this state of indifference [or neutrality] and assuming existence along with its properties, that would amount to a violation of the law of identity in essence (*Inqilab*; lit. 'revolution'), which is impossible. Hence it is existence that brings quiddity out of its state of indifference and is

> fundamentally real. (Tabatabai, 2019, p. 22)

The second principle is *the gradation of existence* (tashkik al-wujud). Although the idea of gradation or the "chain of being" starts from *materia prima* to upper realms such as mineral, vegetable, animal, man and so on, is already to be found in Greek thought, especially in Aristotle and his Alexandrian commentators, it gains a new meaning in light of the first principle (the ontological primacy of existence over quiddity). According to this, not only is there a gradation of existents which stand in a vast hierarchy, but the existence of each existent quiddity is nothing but a grade of the single reality of existence whose source is the Absolute Existence (*al-wujūd al-muṭlaq*). The Absolute Existence is like the sun, and all existents are like points on the rays of the sun. These points are all light and are distinguished from other lights not by a specific difference as one would have in Aristotelian logic, but *by nothing other than light itself*. What distinguishes the existence of various existents is nothing but existence in different degrees of strength and weakness (Nasr, 1989, p. 423. See also: Tabatabai, 1995, p. 17). Tabatabai's defense of this principle is as follows:

> The truth is that existence is one graded reality. Were it not one reality, entities would have been disparate from one another with the totality of their essences. That would entail that the concept of existence, which is a single concept, as said, has been abstracted from disparate things qua disparate things [having no unifying aspect]. This is impossible. To explain, there is an essential unity between a concept [i.e., the concept of existence regarding *the ontological primacy of existence over quiddity principle*] and that to which it refers. The factor of disparity lies in existence being mental or external. Were something which is one, qua one, capable of being abstracted from that which is many, qua many, one qua one would be the same as many qua many, which is impossible. […] As to existence being a gradational reality, since it manifests various real perfections that make up the distinctive attributes that are not extraneous to the single reality of existence, such as intensity and weakness, priority and posteriority, potentiality and actuality, etc., existence is a single reality multiple in itself, wherein all that makes existents differ refers to what is common to them, and vice versa. This is what is called gradation (*ta'shkik*). (Tabatabai, 2019, p. 27)

Regarding these two principles, we can elucidate the doctrine of 'motion

in substance.' For the purpose of this paper, that is, to formulate a realist theory of laws of nature, we're not going to prove this doctrine from an argumentative method. But instead, we try to explain its meaning and consequences on our natural worldview. The word 'Nature' itself and the difference it finds among late Islamic philosophers is also a good conceptual mediator to explain the doctrine of motion in substance.

Islamic philosophers cared a lot about the word "Nature." Ibn Sina uses the word "Nature" with several meanings, of which the most essential is the force responsible for causing the *elements* to *change*. Nature keeps an element (e.g., fire or water) at rest if it is in its right status, and makes it change toward its correct status if it is out of its natural status. "Tendencies of lightness and heaviness are due to Nature, which here implies the form of the elements, the form which gives them the particular qualities that they possess" (Nasr, 1978, p. 216).

Hence, for example, it is the nature of water that is responsible for its descent from the sky to place it in its proper status on earth, and that is the nature of air, which is responsible for its rising into the sky to place it in its proper status in the sky. So it would be the case that the concept of 'Nature' in the Islamic philosophical tradition and the laws of nature in modern philosophy of science are related in meaning. However, it also appears that the concept of 'Nature' as used by Ibn Sina is very similar to the concept of 'disposition' as employed in B-Theory to explain laws.

Thus, by the term "Nature", Islamic philosophers do not mean the world of matter as a whole, but rather refer to a more specific metaphysical concept that corresponds to causal roles in the material cosmos. Considering the relation of Nature to motion, according to Ibn Sina, all objects in this world must be moved (that is, changed) by an outside cause, as in the case of the heating of water, or by an inner cause which belongs to their essence, as in the case of the growth of a seed into a plant (Nasr, 1978, p. 217). This thesis is clearly Aristotelian.

But for late Islamic philosophers (i.e., since the early 19th century), the view of Mulla Sadra has become dominant. By critiquing this Aristotelian metaphysics, which assumed that the basic cause of change in nature was 'Nature', Mulla Sadra proposed "a (Neoplatonic) process metaphysics of change, founded upon and moved by acts of *Existence.*" He thinks that because contingents get their existence from their existential cause[1], existence is *ontologically* prior to essence, as said

1. Regarding the principle of the ontological primacy of existence over quiddity, existential

above. For Mulla Sadra, Aristotelian substances (and what belongs to them, such as Nature) are not ontologically primary. They are merely dependent on existence. In his doctrine of motion in substance, mentioned below, we can see a systematic rejection of the Aristotelian metaphysics of substance, essence, Nature, etc.

Concerning the topic of motion, that is, gradual change in the natural world, recent Islamic philosophers such as Tabatabai, influenced by Mulla Sadra's thought, consider all changes to be a form of motion, and accordingly, introduce the idea of "Motion in Substance" (or in some translations "Substantial Motion"[1]). Motion in substance is a key metaphysical doctrine, introduced as a basis for a new ontological framework that differs from Ibn Sina's metaphysics. Ibn Sina explicitly refuted such an account of motion, arguing "that since the essence of a thing depends upon its substance, if that substance were to change, its essence would also change and lose its identity," and this is impossible (Nasr, 2013, pp. 283–84).

The main claim of Ibn Sina is that motion requires a stable subject within which the motion can occur. If the very essence of substance (material substance) were to undergo change, the existence of a unique subject for the motion would be negated. In other words, Ibn Sina contends that to attribute change and motion to the accidental properties, we should have an unchangeable subject that accepts the continuous changes of accidental properties.

This impossibility becomes possible in the light of the two metaphysical principles discussed above. For Mulla Sadra, essences are not ontologically fundamental to which existence is accidental. He argues that it is the existence that manifests Natures, and existence constantly changes. One implication of this doctrine is to consider time as a secondary effect of existence, "as an analytic property of substantial

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cause would have a specific meaning which differs from the ordinary understanding of the term that says a contingent entity comes into existence from the process that brings it into existence. In the quotation below, Tabatabai defines 'cause' and 'effect' regarding this principle:

> *[…] it is the existence of quiddity that depends on something other than itself. That dependence also inevitably relates to the existence of the other thing, for a non-existent as such has no entity. The existent on which the existence of quiddity depends is called the 'cause,' and the quiddity whose existence depends on it is called the 'effect.' (Tabatabai, 2019, p. 146; see also: Tabatabai, 2008, pp. 166–69)*

1. It seems that the term 'Motion in Substance' is a better translation than 'Substantial Motion' because of the original usage of the term, but I will use both terms interchangeably.

motion, having no existence independently" (Rizvi, 2021, Sec. 3.2).

Mulla Sadra argues that all changes occur at the level of a substance, and the reason that accidents are changing is owing to the continuous changes of a substance. The key principle underlying motion in substance is *the inseparability of the changing substance within its accidental properties, and the motion itself*. This leads to the conclusion, as articulated by Mulla Sadra, that the subject of the change and the change occurring are indistinguishably interwoven. This theory states that because of an essential and substantial change, every material substance takes on a new form at every instant (of its existence) that differs from the previous one.

In the quotation below, Tabatabai briefly expresses his opinion about the doctrine of motion in substance:

> […] One may also argue in favour of motion in substance on the basis of what was mentioned earlier, that the existence of the accident is a plane from among the planes of the existence of substance, in the respect that its existence-in-itself is identical with its existence-for-the-substance. Hence its change and renewal are change and renewal in the substance.[1]
>
> It follows from the above discussion, first, that the changing natural forms that appear one after another in matter are in reality a single substantial form in *flux* through which matter passes, and from each of whose limits is abstracted a concept [by our mind] different from what is abstracted from another limit.
>
> This was concerning change in natural forms (e.g. water into vapour and vapour into water), which is change within a single form in flux. But there are other evolutionary motions in substances represented by the motion of prime matter towards physical form, followed by vegetative, animal, and human forms.
>
> Second, in its motion in substance, the moving substance moves with all its accidents, for, as mentioned, the existence of accidents is a plane of the existence of the substance, which is their substratum.

1. This is the last and also the simplest argument Tabatabai argued in favour of motion in substance. For more detailed discussion (see: Tabatabai, 2019, pp. 205–35; Tabatabai, 2008, pp. 238–39)

> A consequence of this is that the motion of substance in the four – or the three – categories [these are: place, quality, quantity, and position] is a kind of motion within [or in] motion. On this basis, these fourfold or threefold motions may be called 'secondary motions,' and the motions that relate absolutely to the accidents in subordination to the substance – not parallel to it – may be termed 'primary motions.'
>
> Third, the physical world with its one matter is a single reality in flux. With all its substances and accidents, it is a single caravan moving towards its fixed end of an absolute actuality. (Tabatabai, 2019, pp. 231–232)

So, by approving motion in substance, Islamic philosophers lost interest in the Aristotelian concept of "Essence," and thus turned against what early Islamic philosophers like Ibn Sina had referred to as the concept of "Nature." From the perspective of the idea of motion in substance, the world, in an ontological sense, is a single reality or existence like a stream or flux, which is continually flowing. Motion is nothing but the continuous regeneration and re-creation of the world at every instant of existence; not only the accidents but also the *substance* (in an Aristotelian term) of the universe itself is in a state of motion and becoming:

> The matter of each being, therefore, is continuously in the process of wearing a new dress, i.e., being wed to a new form […]. It is only the rapidity of this change that makes it imperceptible and guarantees the continuity and identification of a particular being through the stages of substantial motion. […] At each stage of substantial change the totality of a being which itself consists of form and matter may be considered to be the matter of the aspect of potentiality for the next stage the actualized aspect of which then becomes the form. The power or force which motivates this change is nature which is a force hidden within the cosmic substance. (Nasr, 2013, pp. 284–285)

Formulating Tabatabai's view and examining its relation to the central dilemma challenge

Based on the doctrine of motion in substance, Tabatabai formulates his idea of *bodily causes*, understood as the causes that act within material objects in the natural world, that is, the world of bodies. Setting aside the question of any supernatural causes that may intervene in the natural

world, this formulation would be Tabatabai's theory of causation, which we may call T-causation. He says:

> [Some of] the metaphysicians[1] hold that bodily species are in substantial motion; hence their specific forms are divisible and analyzable into limits and stages, each of which is bracketed by two non-beings. They are finite in themselves as well as in their external effects.
>
> Also, bodily causes do not act without there being a special configuration between them and the matter of the thing affected. The metaphysicians state that since the bodily cause needs matter for its existence, it also needs matter for bringing something else into existence (i.e., effects). Its need for matter in bringing into existence lies in its attaining through matter a special position in relation to the thing affected. Hence proximity and remoteness and special configurations interfere in the effectiveness of bodily causes. (Tabatabai, 2019, p. 170)

At first glance, Tabatabai's concept of T-Causation appears to resemble Bird's notion of B-Causation. In both frameworks, the essences of natural kinds are cited as components that play a causal role, and the cause-and-effect relation requires spatiotemporal proximity. These views differ significantly from Armstrong's perspective, where causation in the natural world is explained by Universals.

However, in Tabatabai's formulation of causation, unlike B-Theory, the essences and the corresponding dispositions seem to lack metaphysical necessity. Consistent with the idea of motion in substance, a key metaphysical doctrine in Tabatabai's thought, forms, as the source of bodily causes in a substance, do not carry metaphysical necessity. Instead, the one necessary aspect for natural substances is their *necessary potentiality for motion and gradual change*, that is, their capacity to accept different forms in the course of motion in substance.

For Tabatabai, since the essence of a natural substance is in continuous gradual change (i.e., motion, due to the doctrine of motion in substance), its causal role in nature is not characterized by necessity. This is because the same material substance, in the course of its unceasing motion, takes on novel forms at each instant of its existence, allowing it to play *ontologically* distinct causal roles compared to those

1. By the term 'metaphysicians', he means intellectuals of late Islamic philosophy such as Mulla Sadra and Hajj Molla Hadi Sabzavari.

it played in the past. Thus, the causal role of natural substances in T-Causation is not characterized by necessity.

To put it more precisely, a fixed form would play a significant causal role and have a fixed effect necessarily. However, that form and its causal role are limited to an instant, because each being of a form "is bracketed by two non-beings" of other forms in an ontological sense, due to the doctrine of motion in substance.

In summary, on this view, metaphysical necessity in nature is limited to motion in substance, and T-Causation, that is, the causation of natural entities, does not have metaphysical necessity. At the same time, the causal roles of a specified natural substance could be ascribed as a necessary physical role, like B-Necessity, but just in an instant of its existence, because a fixed natural substance, at an instant of its existence, necessarily has a fixed form, and due to this form, has a fixed causal role. This is what we call T-Necessity in nature. In other words, using Bird's terminology of stimulus and manifestation, this means that with respect to T-Theory, we could formulate the state of an entity x due to its special form F at an instant as follows:

$$(\exists x)((Fx\&Sx) \rightarrow Mx)$$

But unlike Bird's account, the general form of this proposition, that is, $(\forall x)\big((Fx\&Sx) \rightarrow Mx\big)$, does not make any reference to extramental reality. Regarding T-Theory, reality is nothing but a single existence in flux and change, and its manifestations, rather than instantiations of natural kinds. It is a mere generalization (just like Lewis's view, i.e., L-Laws) that we undertake through an act of reasoning in the realm of our minds, after repeatedly observing the renewal of $(\exists x)((Fx\&Sx) \rightarrow Mx)$, as is given in our perception due to the motion in substance of x (Tabatabai, 2008a, pp. 166–167). The existence of the related stimulus and manifestation also depends on the existence of the individual thing x.

According to what has been said, the following components seem to give a suitable formulation of T-Theory:

- T-Theory is based on two principles and one doctrine: 1) The ontological primacy of existence over quiddity (essence) in contingent beings, and 2) The gradation of existence, and 3) The doctrine of motion in substance. According to T-Theory:
    - There is a single existence, like a flux or stream in the world, and essences or quiddities are not real things in the literal sense. However,

our understanding of them is rooted in reality because they are manifestations of existence.

- The only metaphysical necessity in the natural world is motion in substance, that is, the continuous regeneration and re-creation of the world at every instant of existence, not only in the accidents but also in the *substance*. The universe itself is in a state of motion and becoming.
- Laws, causes, forms, and quiddities are independent in the strong sense that none of them is ontologically dependent on the others. However, all are dependent on the existence and its manifestations. Therefore, we can assert that laws cannot be reduced to quiddities but are instead a type of existence manifestation.

The distinction between metaphysical necessity and physical necessity requires further clarification. As previously noted, the necessity intrinsic to substantial motion, as articulated by Tabatabai, is best understood as metaphysical necessity. By contrast, the necessity that governs causal relationships among entities possessing quiddities can be more accurately described as physical necessity.

Hence, T-Theory must be categorized as an RLN, since laws in the world have roles that cannot be reduced to quiddities or any other particular entities. In T-Theory, L-Laws can also be considered more fundamental than essences or quiddities in an ontological sense, because an essence or a quiddity refers to the manifestation of existence in an instant, whereas laws are independent of instants and relate to the stream of matter (Tabatabai, 2008a, pp. 94–96). Based on this point, we can attribute the term 'govern' to laws in T-Theory, a concern that was more followed in the A-Theory.

For Tabatabai, causation in the literal sense is limited to the relationship between existence, as cause, and its manifestations, as effects (Tabatabai, 2008b, pp. 314–315). Since quiddities are all effects, that is, manifestations, any relations similar to cause-effect relations between them can only be described metaphorically in terms of cause and effect. Thus, the real cause of everything in the natural world is the single existence, which is ontologically prior to quiddities. This idea about causation, that is, L-Causation, aligns with the Humean approach to causation. In both views, regularities in nature do not imply ontological relationships between natural entities.[1]

1. As Stoljar mentions, the necessary condition of physicalism, based on supervenience and required by L-Theory, is consistent with the existence of abstract entities in all possible worlds (Stoljar, 2017, Section 5.3). The single existence in T-Theory could be

In Tabatabai's metaphysics, ontology is based solely on existence and nothing else. Quiddities and laws are manifestations of existence. When confronting T-Theory with the central dilemma, it seems that this theory, as an RLN, can provide a different answer that has advantages over other theories. Regarding the central dilemma challenge, the second horn may be problematic for T-Theory because it does not address the role of universals in nature like A-Theory. In response to the second horn, T-Theory posits that 'laws are not internal to quiddities'; instead, both laws and quiddities are rooted in existence. This means both laws and quiddities originate from a more fundamental reality, which in Tabatabai's metaphysics is existence itself.

Table 2 Tabatabai's Thought about Laws of Nature in Summary

		T-Law	T-Necessity	T-Causation	Faced with the central dilemma
T-Theory	Modal Priority	II(All originate from a single existence in flux)			It could be considered an RLN because it makes laws a more fundamental approximation of the single existence than quiddities. In confronting the second horn of the central dilemma, it posits that laws and quiddities are independent of each other and rooted in existence and its manifestations.
	Existence + Manifestations	General propositions of the form: $(\forall x)\big((Fx\&Sx) \rightarrow Mx\big)$ are arrived at by reasoning when confronted by regularities rooted in the renewal of $(\exists x)((Fx\&Sx) \rightarrow Mx)$ that substantial motion of x presents in our perception. That general form, in its generality, does not have any concrete reference point in extramental reality.	The relation between forms and their results on stimuli and manifestations is necessary, but just for an instant! What has metaphysical necessity in the natural world is substantial motion, which overshadows the Aristotelian concept of "Essence" and makes the world, in an ontological sense, like a stream, that is, a continuous renewal of forms.	The real cause of everything in the natural world is the single existence, which is ontologically prior to quiddities. However, in metaphorical terms, we can talk about T-Causation regarding the spatiotemporal bodily causes of natural kinds, which are rooted in existence and observed by us within the regularities of nature.	

considered as a necessary condition for all possible worlds too.

Conclusion

The doctrine of motion in substance creates the space for Tabatabai's ideas about the laws of nature. His views are too distinct from contemporary realist theories to be labeled as one of the classic theories previously discussed and comparatively summarized in Table 1, with respect to three essential metaphysical concepts: laws, causation, and necessity regarding the central dilemma challenge.

The two principles about existence–the ontological primacy of existence over quiddity and the gradation of existence–and the doctrine of motion in substance, draw a very different metaphysical picture. Within this framework, T-Theory, as formulated in Table 2, could be counted as a nascent realist theory of laws of nature. This metaphysical perspective posits that reality consists solely of existence and its manifestations. Thus, categories such as quiddities and laws, although rooted in reality, do not contribute to ontology. Therefore, they are independent of each other.

Furthermore, quiddity is related to the manifestation of existence in an instant, which is "bracketed by two non-beings," while laws seem to be rooted in the manifestation of existence in flux, which is necessary for the natural world and not limited to an instant. From an ontological perspective, laws are more fundamental than quiddity, and therefore, T-Theory can be considered an RLN.

Finally, in facing the challenge of the central dilemma, our theory offers a different answer. The question of 'how can something govern or determine that to which it is reducible?' dissolves because laws are not internal to quiddities; both are rooted in existence and its manifestations. Thus, our theory provides an ontological explanation in which there is no direct ontological relationship between laws and essences or quiddities, but they are related through existence, with everything they have deriving from existence.

Clearly, many questions remain to be answered about this new metaphysical picture. The efforts of philosophers in the late tradition of Islamic philosophy have aimed at addressing these questions. In this article, we have tried to answer a question that these philosophers themselves did not address, from the perspective of their intellectual tradition.

Conflict of Interests

The Authors Declares No Competing Interests.

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