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A Compatibility Law and the Classification of Theory Change

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Abstract

The current formulation of *the zeroth law* (the law of compatibility) is marred with a number of theoretical problems, which necessitate its reformulation. In this paper, we propose that *compatibility* is an independent stance that can be taken towards epistemic elements of all types. We then provide a new definition of *compatibility criteria* to reflect this change. We show that the content of the zeroth law is deducible from our definition of *compatibility*. Instead of a static law of compatibility, we propose a new dynamic *law of compatibility* that explains how the stance of compatibility obtains. Unlike the zeroth law, this new law has empirical content, as it forbids certain conceivable scenarios. Having established these notions, we propose a classification space that exhaustively covers all the possible states a theory may occupy and all the transitions it may undergo during its lifecycle.

Introduction

It is currently accepted in scientonomy that the *compatibility* of elements in a scientific mosaic plays a vital role in the process of scientific change. Current attitudes in the scientonomic community, however, are that the present conception of compatibility is inadequate. Specifically, the notion of compatibility in the *zeroth law* mostly plays its role as a heuristic insofar as it merely presents a description of a certain phenomenon in the process of scientific change rather than providing an explanation of the mechanism of compatibility. In fact, it is an open question as to whether or not this law has any empirical content.

We begin by highlighting what we find problematic with the *zeroth law*. We then provide a definition for *compatibility*, redefine *compatibility criteria*, and use these concepts to propose the *law of compatibility* in order to better reflect the general manner in which compatibility changes over time. Using these notions alongside the *law of theory demarcation* and the *law of theory acceptance*, we argue for a *logical* structure connecting the assessments by the demarcation, acceptance, and compatibility criteria. We contend that scientific demarcation of a theory is logically prior to its acceptance, since scientific communities do not appraise unscientific theories for acceptance (Sarwar & Fraser, 2018). We then show that evaluations by the acceptance criteria are logically prior to those by the compatibility criteria, because concerns about a theory's compatibility with other theories in the mosaic arise only when it has already been accepted.

Inadequacies of the Law of Compatibility

Let us first consider the current formulation of the *zeroth law* (Barseghyan, 2015, p. 153):

The Zeroth Law

At any moment of time, the elements of the scientific mosaic are compatible with each other.

This law emphasizes that all epistemic elements (accepted theories, accepted questions, and employed methods) in a mosaic are mutually compatible at any given time (Barseghyan, 2015, pp. 157-64; Rawleigh, 2018). Consequently, no accepted theory can be incompatible with any other accepted theory, employed method, or accepted question; the same goes for accepted questions and employed methods.

As such, the *zeroth law* pertains only to mosaics and says nothing about the compatibility of elements outside the mosaic (Barseghyan, 2015, p. 157). Moreover, the *zeroth law* attempts to explain the process of scientific change from a static perspective, while the other three laws do so dynamically, meaning that the latter describe the process of scientific change *as it is happening*. For heuristic purposes, if we 'pause' the scientific mosaic, then "we would notice that its elements are mutually compatible" (Barseghyan, 2015, p. 152-153). This 'pause' factor gives the law its idiosyncratic name.

Although this point is not explicitly stated, the newly proposed *law of theory demarcation* is also diachronic (Sarwar & Fraser, 2018).

The *law of compatibility*, as it currently stands, has serious flaws. An adequate *law of compatibility* must describe and explain the role that compatibility plays *during* the process of scientific change. The first two reasons show why the *law of compatibility* must be diachronic, and the third reason highlights an issue in the necessity of such a law and the distribution of epistemic content within scientonomy.

First, the laws of scientific change are intended to play a significant *explanatory* role in our understanding of scientific change. They all take as their object of study scientific mosaics that essentially behave in a dynamical fashion. Accordingly, in order for the *law of compatibility* to have the same degree of explanatory weight as the other laws, it must likewise be able to present a dynamical, rather than a static, description of how mosaics change. While there may be some value in characterizing scientific change from a static perspective, such characterizations do not play the same explanatory role as the laws that describe the actual mechanics of the process. Consider an analogy: within the standard Lagrangian framework of classical mechanics, static

descriptions of physical systems are significant insofar as they provide initial conditions. However, such descriptions do not explain the trajectories and general motions of physical systems; the dynamical law of minimal action via the Euler-Lagrange equations is required for this (Landau & Lifschitz, 1976). Similarly, the current formulation of the law of compatibility presents a static description, but it is incapable of dynamical explanation. Namely, it fails to explain how exactly a pair of theories comes to be considered compatible or incompatible. Thus, we need to reformulate the *law of compatibility*, so that it has explanatory content.

Second, whereas 'freezing' scientific mosaics may help students of scientonomy better observe the compatibility of its elements, static depictions add nothing new to our knowledge that is not already captured by a dynamical notion. Consider the example of the mechanics of gears in clocks that undergo constant motion. Clockmakers must understand, for instance, how the angular velocity of a gear is related to the angular velocity of a driven gear connected to it. It is undoubtable that any system undergoing change, be it a clock, a society, or a scientific mosaic, is by definition dynamical and that such a system could be conceptually paused. For instance, the angular velocity relationship may be understood statically in terms of the ratio of the radii of the two gears with no reference to any sort of dynamical change. Other than being a heuristic tool that enables students to understand how different features of the system fit together, a static characterization adds nothing new to our understanding of the mechanisms underlying clockworks. For instance, knowing how the ratio of radii relates to the respective angular velocities of gears allows one to calculate physical quantities, but it does not provide an *understanding* of how the system actually evolves dynamically. Likewise, the present formulation of the compatibility law does not present additional content that the dynamical conception itself does not capture.

Occam's razor dictates that if there exist theoretical postulates that provide sufficient explanations of phenomena, positing additional theoretical entities or relations is not parsimonious. It follows from the above discussion that since a dynamical conception may be sufficient to explain the process of scientific change, there is no need to posit static conceptions except for their pedagogical use. Consequently, any *law of compatibility* should be dynamical in nature.

Our third argument is that the *zeroth law* does not have any empirical content, because it follows directly from the notion of compatibility. While the term *compatibility* does not currently have an accepted scientonomic definition, it is roughly understood to be the ability of two elements to coexist within a particular mosaic. If this explication of the community's tacit definition is adequate, then the content of the *zeroth law* follows immediately from it. As such, it does not warrant the label of 'law'. The *zeroth law* appears to bear no empirical content and, hence, it does not seem to provide anything above and beyond what is already present in the definition of *compatibility*.

It may be tempting to argue that our third criticism seems to imply that a *compatibility law* may not be needed at all. Yet, there remains the question of how compatibility of elements changes over time. One is left wondering how a pair of previously compatible elements is no longer compatible. This question is within the scope of scientonomy, as it concerns potential changes in a mosaic, and as previously shown, it cannot be answered by relying exclusively on definitions. Thus, a diachronic law of compatibility with empirical content is needed. Before such a law is proposed, we must demonstrate why compatibility is a distinct *epistemic stance* and make explicit some crucial features of the *compatibility criteria* that scientonomists have thus far accepted only implicitly.

A metaphysical argument supporting our view could be made: the reference to "at any moment of time" in the *zeroth law* tells us that compatibility is a synchronic feature of the mosaic, as it captures the relations between the elements at a given instant. In other words, compatibility is a property which can be 'read off' of a paused mosaic. Currently, the term *scientific mosaic* is defined as "a set of all accepted *theories* and employed *methods*" (Barseghyan, 2015, p. 5). If compatibility is an intrinsic feature of the mosaic, then one can incorporate this notion into the mosaic's definition. For instance, consider for the sake of argument a hypothetical scenario where *scientific mosaic* is redefined as "a set of accepted theories and employed methods that are mutually compatible". The only change in this redefinition is that the mutual compatibility of the elements of the mosaic is now an essential feature of it. In this scenario, the *zeroth law* would directly follow from this new definition of the *scientific mosaic*, thereby demonstrating the vacuity of the former.

Compatibility and Compatibility Criteria

We propose the following definition of *compatibility*:

Compatibility ≡
The ability of two elements to coexist in the same mosaic.

Compatibility is a distinct epistemic stance that agents can take towards elements. We dissociate it in principle from other epistemic stances – acceptance, use, pursuit, as well as the new stance of scientificity that we suggested earlier (Sarwar & Fraser, 2018). If one is to show that two stances are not identical, one must demonstrate that, in some (conceivable) instance, an agent can take one of the stances without taking the other. We will show that scientific communities can and do take one stance without taking the other, thus providing sufficient grounds for accepting that two stances are distinct.

First, *compatibility* is distinct from *acceptance*. Although all elements in the mosaic are in principle compatible, there may be unaccepted theories (or other elements) that are compatible or incompatible with elements in the mosaic. Recently rejected theories are undoubtedly incompatible with at least one element that was recently accepted. The epistemic stance of compatibility is not the same as the stance of acceptance, because epistemic agents can also evaluate the compatibility of *unaccepted* theories. Nonetheless, compatibility and acceptance are related, because all accepted elements are necessarily compatible. These relationships are shown below:

Discussing the possibility of the coexistence of unaccepted theories introduces counterfactuals. One may, therefore, be inclined to say that without proper treatment by modal logic, one should not make any claims about the coexistence of contender theories. However, epistemic agents *do* reason counterfactually without treatment by modal logic. If we consider democratic electoral systems, for instance, candidates make promises about what they would do if they are elected. The voters make decisions counterfactually by envisaging those scenarios. So, decisions are counterfactually made by epistemic agents in the absence of modal analysis. It is in this sense that scientific communities may counterfactually decide whether or not two unaccepted theories could possibly coexist. Hence, it is conceivable that epistemic agents take the stance of compatibility towards theories outside of their mosaics.

	Accepted	Unaccepted
Compatible	**Necessary**	Possible
Incompatible	*Impossible*	Possible

Likewise, *use* and *compatibility* are distinct stances, because epistemic agents are perfectly capable of using theories regardless of their mutual compatibility. For example, quantum mechanics is used and accepted by the contemporary scientific community (Barseghyan, 2015, p. 39) and, since it is accepted, it is also compatible with other theories in the mosaic. By contrast, evolutionary biology does not appear to have immediate practical applications even though it is accepted and, thus, is compatible with other theories in the mosaic (Futuyma, 1995). Therefore, there are compatible theories that are used and compatible theories that remain unused.

After commenting that evolutionary biologists "are happily disengaged from the practical applications of their field to human affairs", Futuyma argues that the few uses evolutionary biology does have are all indirect (Futuyma, 1995, p. 1).

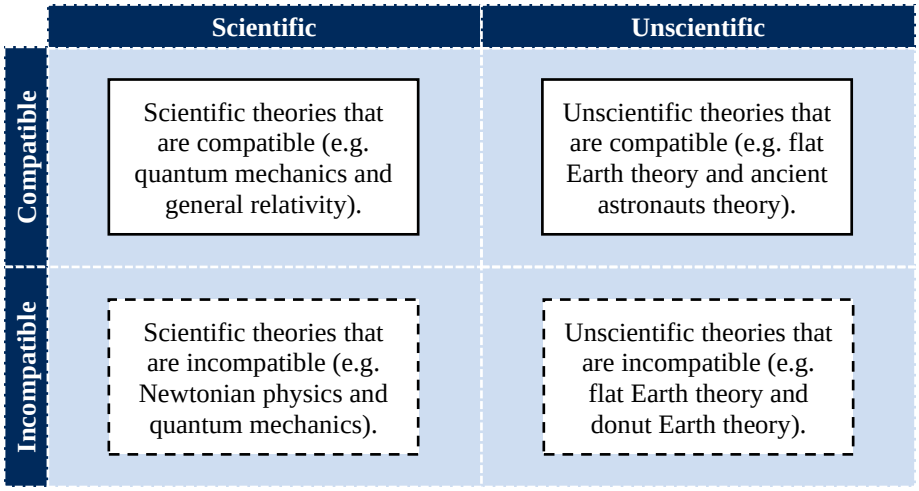
Further, *pursuit* and *compatibility* are distinct epistemic stances, as epistemic agents may pursue theories that are compatible or incompatible with other elements of the mosaic. An example of a pursued theory that is incompatible with elements of the current mosaic is superstring theory (Smolin & Harnad, 2008). Similarly, epistemic agents may pursue accepted (and compatible) theories to further develop their knowledge. Evolutionary psychology is a pursued theory that expands our understanding of psychology using the currently accepted evolutionary biology. Consequently, compatible and incompatible theories can be pursued, making it clear that the two are distinct epistemic stances.

Finally, *scientificity* and *compatibility* are distinct epistemic stances. For one, two scientific theories may or may not be compatible. On the one hand, there are theories that are scientific and compatible. For example,

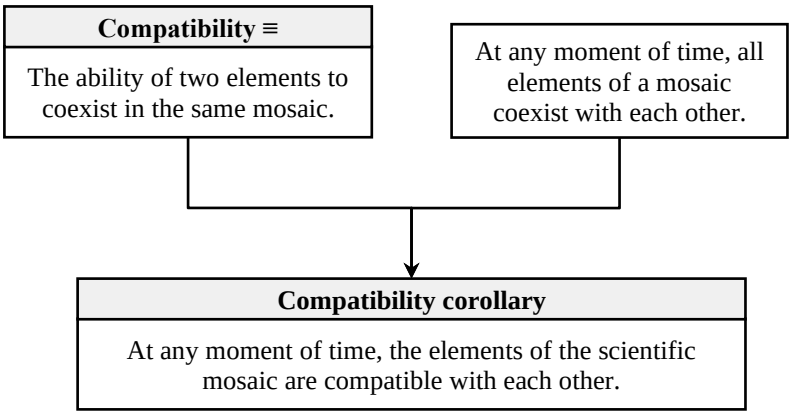
quantum mechanics is a scientific theory that is compatible with other elements of the current mosaic such as general relativity. On the other hand, there are scientific theories that are incompatible with other theories. For instance, the scientific community deems Newtonian physics as a scientific theory despite the fact that it is, strictly speaking, incompatible with some elements of the current mosaic (e.g. quantum mechanics), a fact made abundantly clear at the monumental fifth Solvay conference in 1927 (Bacciagaluppi & Valentini, 2009), where the founding figures attempted to resolve disagreements between experimental data and classical physics by developing quantum mechanics.

Alternatively, two unscientific theories may or may not be compatible. First, there are theories that are unscientific and incompatible. Both the flat Earth theory (Garwood, 2008) and the donut Earth theory (Hale, 2018) are currently considered unscientific; in addition, they are clearly incompatible with one another, despite the fact that the latter is sometimes presented as the species of the former (Hale, 2018). Second, there are theories that are compatible but are not scientific. If we search for unscientific theories that concern sufficiently different topics, then it is likely that they would be compatible. For instance, flat Earth theory is compatible with the theory of ancient astronauts (von Däniken, 2018). Since scientists generally do not spend time evaluating the compatibility of unscientific theories, it is unlikely that there exists any substantial historical record of such cases.

The relationship between the stances of compatibility and scientificity is as follows:



The definition of compatibility enables us to recover the content of the *zeroth law*: if compatibility is the ability of elements to coexist within a mosaic, then any elements that are not compatible cannot exist in the same mosaic. Mosaics are, strictly speaking, sets of elements that coexist. Thus, all elements of a mosaic must be mutually compatible. The content of the *zeroth law* is simply a trivial corollary that follows straightforwardly from the definition of *compatibility*:



It is now pertinent to also slightly modify the definition of *compatibility criteria*. The current definition is:

Compatibility Criteria ≡
Criteria for determining whether two theories are compatible or incompatible.

This definition excludes a simple point that is assumed elsewhere in scientonomy: elements other than theories (i.e. methods and questions) may be compatible or incompatible with other elements (which, again, need not be theories). For example, this terminology has already been used in the *method rejection theorem* (Barseghyan, 2015, pp. 172-173) even though the current definition of compatibility does not extend to them. Hence, we suggest that the word 'theories' be changed to 'elements' to account for the fact that the compatibility criteria apply to theories, methods, and questions alike. The modified definition is as follows:

Compatibility Criteria ≡
Criteria for determining whether two elements are compatible or incompatible.

The functional role of the compatibility criteria needs further explication that relies on differentiating its structure from that of the demarcation criteria. When a theory is evaluated by the demarcation criteria, it is mapped onto an output value that describes its scientific status. The demarcation criteria act, as it were, like a black box that takes as its input a theory and, after processing by the demarcation criteria, the scientificity of the theory exits as an output value. Indeed, the nature of this 'processing' is the fundamental issue in the classical debate of what demarcates science from non-science. This output value is the scientificity of the input theory; the possible assessment outcomes are scientific, unscientific, or uncertain. The demarcation criteria are characterized by this function-like behavior.

Arguably, the acceptance criteria behave in a similar fashion. It may be interesting to investigate the possibility of construing scientonomy in terms of a first-order predicate language which captures this structure.

By comparison, *compatibility criteria* may be understood as reflexive, symmetric, and binary relations between any two elements (theories, methods, or questions): if element *A* is compatible with element *B*, then element *B* must be compatibility with element *A*. These qualities of the compatibility relation are captured by the new definition. However, compatibility need not be transitive. Consider a hypothetical agent for whom two theories are compatible if and only if they are logically consistent. Let theory *A* be "all apples are red", theory *B* be "all apples are either red or green", and theory *C* be "all apples are green". Then *A* and *C* are both properly entailed by *B*. For this agent, *A* is compatible with *B*. Likewise, *C* is compatible with *B*, and by symmetry, *B* is compatible with *C*. However, *A* contradicts *C*, and so for this agent *A* is not compatible with *C*. Hence, transitivity does not work in general, but only with respect to a given mosaic. This is because incompatible elements cannot coexist in the same mosaic.

Not all binary relations are symmetric. For example, if "person *A* is a parent of person *B*," then it does not follow that "person *B* is a parent of person *A*". Thus, the symmetry of compatibility criteria is a special type of binary relation. Interestingly, if one considers compatibility to be an accessibility relation between possible scientific mosaics, there would seem to be a natural extension to modal logic. In particular, since such an accessibility relation is symmetric and binary, the modal system to use would be *B*, i.e., precisely that system which deals with modality and belief. This is fitting as scientific mosaics may, in a certain sense, be viewed as belief systems.

The Law of Compatibility

Equipped with the machinery previously described, we can now propose a new *law of compatibility* that resolves the problems inherent in the *zeroth law*:

The Law of Compatibility

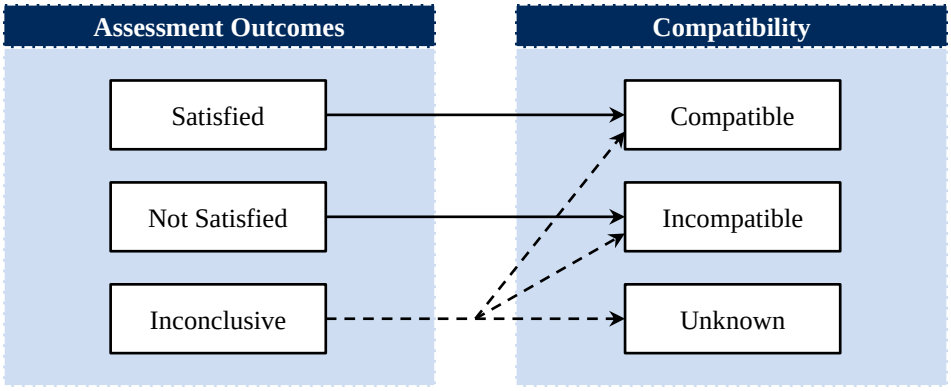
If a pair of elements satisfies the compatibility criteria employed at the time, it becomes compatible within the mosaic; if it does not, it is deemed incompatible; and if assessment is inconclusive, the pair can become compatible, incompatible, or its status may be unknown.

Unlike the *zeroth law*, which describes compatibility in a synchronic manner, the *compatibility law* explains the process of scientific change dynamically. The new law captures the previous conception that elements are compatible with one another while still realizing that this occurs during the process of change itself.

Just like the laws of theory acceptance and demarcation, the *law of compatibility* implies that three possible assessment outcomes can be obtained: satisfied, unsatisfied, and inconclusive. If an element satisfies the compatibility criteria employed at the time, then it is necessarily considered compatible with elements of the mosaic. If an element fails to satisfy the compatibility criteria, then it is deemed as incompatible. The only assessment outcome that leads to difficulty is inconclusiveness. It is unclear at this stage whether or not this assessment outcome is possible for compatibility. However, since epistemic agents may or may not have a conclusive opinion on the compatibility or incompatibility of a pair of elements, the inclusion of this assessment outcome acts as insurance for possible future case studies wherein inconclusive assessments may obtain. Consequently, we must account for all these possibilities to make this law sufficiently general.

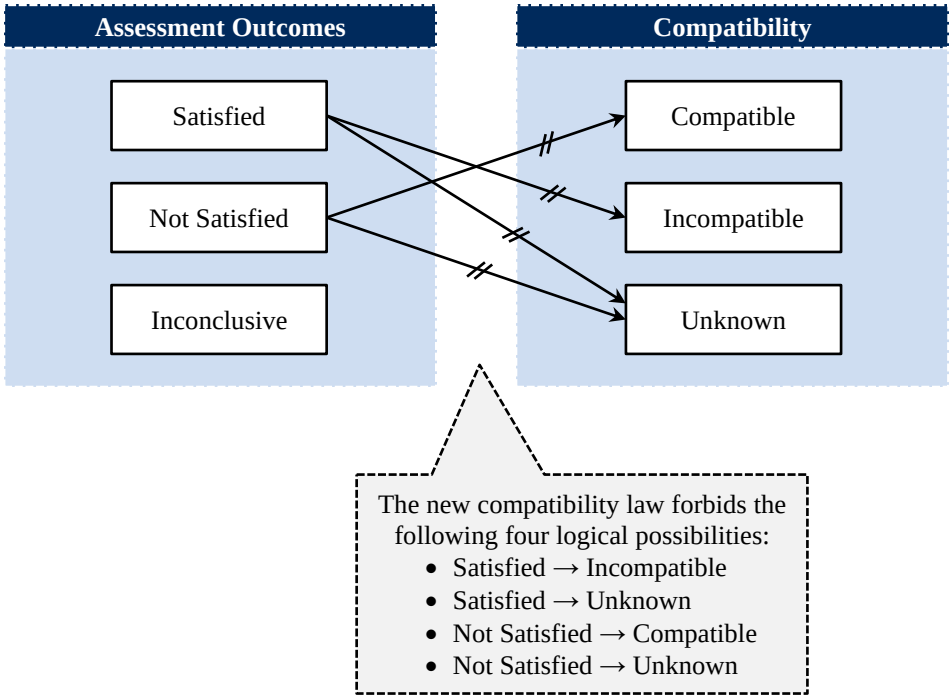
For instance, within the mathematics community, it is not clear what the precise assessment outcome of compatibility would be for the relatively new *univalent foundations* program, which seeks to provide a formal structural foundation for mathematics based in higher category theory rather than in set theory (The Univalent Foundations Program, 2013).

Because it is not yet clear that there may be inconclusive outcomes when assessing for compatibility, it is therefore also unclear what the consequences of this assessment outcome would be. It is possible for a pair of elements whose assessment is inconclusive to be deemed compatible or incompatible. However, just as inconclusive assessment for acceptance can lead to a mosaic split (Barseghyan, 2015, pp. 202-216) and assessment for scientificity can at times leave the scientific status of a theory uncertain (Sarwar & Fraser, 2018), some additional conceivable scenario may obtain as a result of inconclusive assessment of compatibility. This unknown scenario is distinct from compatibility and incompatibility just as mosaic split is different from acceptance and unacceptance. The relation between assessment outcomes and their effects can be represented as:



It is clear that this new law is non-tautological, as it prohibits certain logical possibilities. If the compatibility criteria are conclusively satisfied, the pair of theories in question cannot be incompatible or its compatibility status cannot be unknown. Similarly, when the compatibility criteria are conclusively unsatisfied, the *compatibility law*

prohibits the pair from being compatible or its compatibility from being unknown. Accordingly, the law can be characterized as non-tautologous, because it forbids the following scenarios:



The new law also explains why some epistemic agents may be tolerant towards inconsistencies. Depending on their employed compatibility criteria, some agents may be willing to simultaneously accept mutually inconsistent theories, while others may not do so. Consider the classic example of quantum mechanics and general relativity. Both theories are currently accepted even though they are believed by the scientific community to be logically inconsistent (Barseghyan, 2015, p. 154). Accordingly, the two theories can remain accepted, because the currently employed criteria of compatibility 'tolerates' the simultaneous existence of two inconsistent theories by adding, for instance, the qualification that inconsistencies may be ignored if they occur at the extrema of the functional regimes of particular theories (i.e. quantum mechanics for Planck-length entities and general relativity for massive entities).

Importantly, in scientonomic context, the difference between compatibility and consistency as distinct concepts need not be explained (although it is presently unclear if inconsistency constitutes a special kind of incompatibility). A better way of understanding *consistency* is that two theories are inconsistent if the epistemic agent appraising them believes that their descriptions of the world cannot be held simultaneously without contradiction. The subtlety here is in the distinction between the agent's stance and actual logical contradiction; it is not necessary that there be an actual logical contradiction between the two theories for them to be inconsistent in the eyes of the agent. As long as the epistemic agent accepts that the theories contradict each other, they can be construed as inconsistent from the scientonomic perspective. For instance, whether or not quantum mechanics and general relativity are actually logically inconsistent is irrelevant here; the pertinent issue is that the community believes them to be contradictory. This only goes on to emphasize that epistemic stances are agent-relative.

With this new law in place, we must provide an account for the theorems (such as the *rejection theorems*) that are currently thought to follow from the *zeroth law*. There are two courses of action: either demonstrate that theory and method rejection theorems are deducible from the new *compatibility law* or provide a refutation of the theorems. We take the former route.

The *rejection theorems* take the *zeroth law* as a premise; since at any moment in time, all elements within a mosaic are mutually compatible, any element incompatible with a newly accepted element is rejected (Barseghyan, 2015, pp. 167-168). This content is recoverable via the *compatibility corollary*. When the

compatibility criteria are conclusively satisfied or unsatisfied by a pair of elements, this pair of elements is decidedly rendered compatible or incompatible, respectively. Ergo, if an element is deemed incompatible with a newly accepted or employed element, the former is rejected, thereby showing that the explanatory content of the *rejection theorems* is recoverable through the new formulations.

To summarize, the *compatibility law* makes clear the relationship between assessment outcomes and their consequences, thus showing that the law is non-tautological. It further explains the role that compatibility plays in the process of scientific change. Finally, the explanatory content of the *rejection theorems*, which depended on the *zeroth law*, is recoverable via the compatibility law.

The Classification of Theory Change

What does the *lifecycle* of a theory look like? How does a theory, which is first conceived by an epistemic agent, become scientific, accepted, and perhaps, ultimately rejected? Currently, scientonomy lacks a detailed description of this process, which we believe is fundamental to understanding the process of scientific change. Providing such descriptions would provide a strong, clear-cut explanation of a significant part of the process of scientific change and it is, we believe, of great importance. In this section, we apply the laws of theory demarcation, theory acceptance, and compatibility alongside other scientonomic tenets to provide such an explanation.

Any and all theories accepted in a scientific mosaic are necessarily scientific. Demarcation plays a logically superior role in this process. Once a theory is deemed scientific, it has the potential of being accepted if it satisfies the acceptance criteria of the time. On these grounds, acceptance is the next logical step. Finally, all elements incompatible with the newly accepted theory are rejected. Later on, the theory itself may become rejected when other elements incompatible with it become accepted. Accordingly, we see that compatibility is the final step that plays a role in the possible lifecycle of a theory. This section ties all of the aforementioned logical steps to demonstrate how the new formulations explain the process of theory change.

First, consider the mechanism of demarcation. The epistemic stance of *scientificity* (Sarwar & Fraser, 2018) elucidates a problem inherent in the definition of *theory acceptance* (Sebastien, 2016):

Theory Acceptance ≡
A theory is said to be accepted if it is taken as the best available description or prescription of its object.

The current definition fails to capture the notion that every accepted theory is necessarily scientific, and for this reason, it needs to be redefined:

Theory Acceptance ≡
An accepted theory is a scientific theory that is taken as the best available description or prescription of its object.

This redefinition, when coupled with the *demarcation law*, leads to a corollary. Since the redefinition of acceptance emphasizes that accepted theories must be scientific, no theory can be accepted if it is unscientific (or uncertain). Moreover, it follows from the *demarcation law* that no theory can become scientific unless it conclusively satisfies the demarcation criteria of the time. As a result, any theory that becomes accepted also satisfies the demarcation criteria employed at the time of acceptance. We can call this *the demarcation-acceptance synchronism* theorem:

The Law of Theory Demarcation

If a theory satisfies the demarcation criteria of the method employed at the time, it becomes scientific; if it does not, it remains unscientific; if assessment is inconclusive, the theory's status can become scientific, unscientific, or uncertain.

Theory Acceptance ≡

An accepted theory is a scientific theory that is taken as the best available description or prescription of its object.

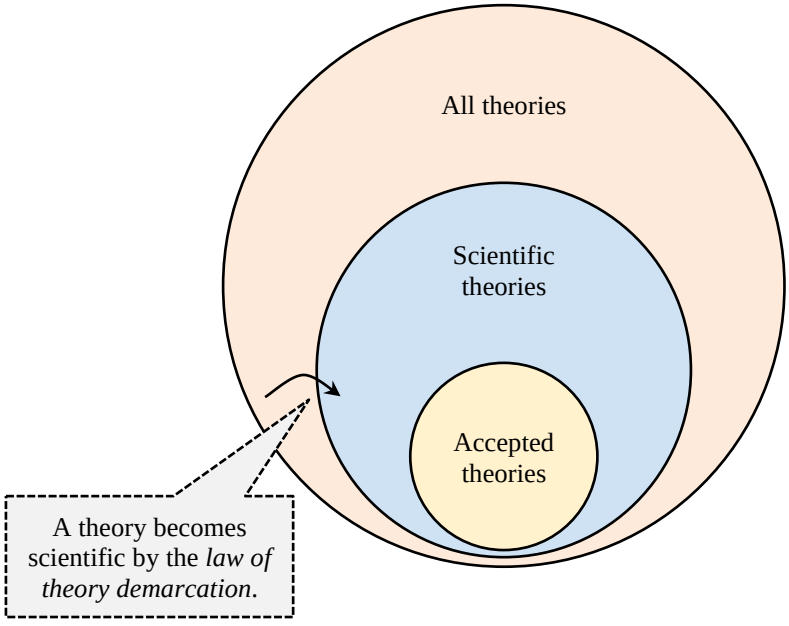
Demarcation-Acceptance Synchronism theorem

Every theory that becomes accepted satisfies the demarcation criteria employed at the time of acceptance.

This indicates that assessments by the demarcation criteria are logically prior to those by the acceptance criteria. We may construe the space of theories as having three categories:

1. the set of theories,
2. the set of scientific theories,
3. the set of accepted theories.

Each successive set is a proper subset of all the former sets. The process of demarcation is the step that takes theories from the set of all theories into the set of scientific theories.

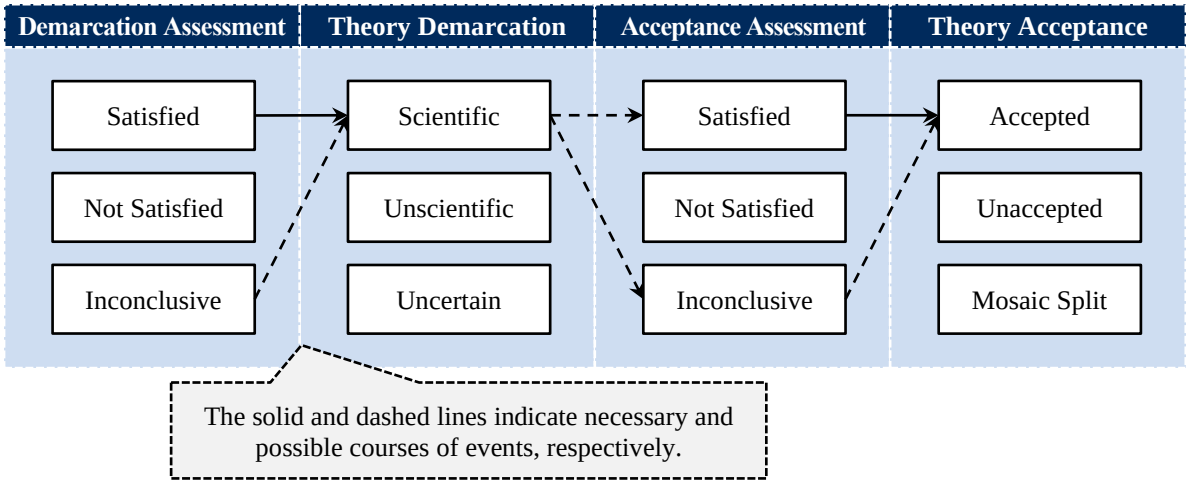


The elements in the set of scientific theories contend to become part of the set of accepted theories. If a theory conclusively satisfies the acceptance criteria, it becomes accepted irrespective of its compatibility with other elements of the mosaic. Why is this the case? We know from the *rejection theorems* that it is only by rejecting previously accepted theories that the mosaic is made compatible again. Counterfactually, if the compatibility criteria assessed theories at the same logical step as the acceptance criteria, then no theory would ever get accepted unless it was compatible with all the elements of the mosaic of the time. Consequently, the scientific mosaic would be an ever-expanding collection of mutually compatible theories that can never be rejected. Both of

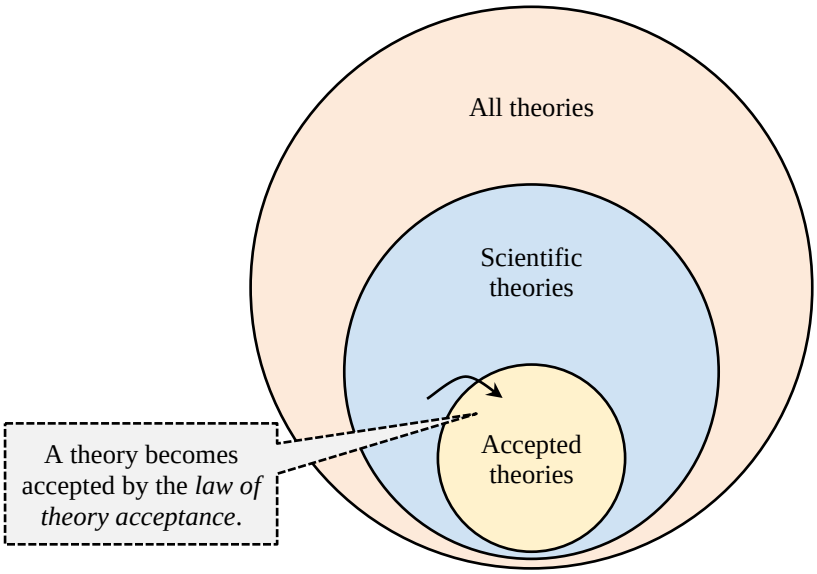
In principle, acceptance criteria can sometimes influence the compatibility requirements. For instance, an epistemic agent may be reluctant to accept a theory when they know that its acceptance may lead to the rejection of other key elements of the mosaic. In such cases, the agent's criteria of acceptance would include a requirement for new theories to be compatible with some key theories (or something to that effect). However, this does not entail that the former criteria's authority is completely rescinded; the logical priority of the acceptance criteria holds.

these cases are historically false. Hence, the acceptance criteria are logically prior to the compatibility criteria in the context of theory acceptance because, if this was not the case, then nothing would ever be rejected from the mosaic; yet, elements are rejected.

What is the relationship between the acceptance criteria and the demarcation criteria? If the assessments of a theory by the demarcation criteria and the acceptance criteria both produce the outcome *satisfied* (Sarwar & Fraser, 2018; Patton, Overgaard, & Barseghyan, 2017, p. 33, respectively), then this is sufficient for the scientific theory to become accepted into the mosaic. However, meeting these conditions is not necessary, because inconclusive assessment outcomes can also lead to the acceptance of scientific theories. The exhaustive list of possibilities is shown in the diagram below:

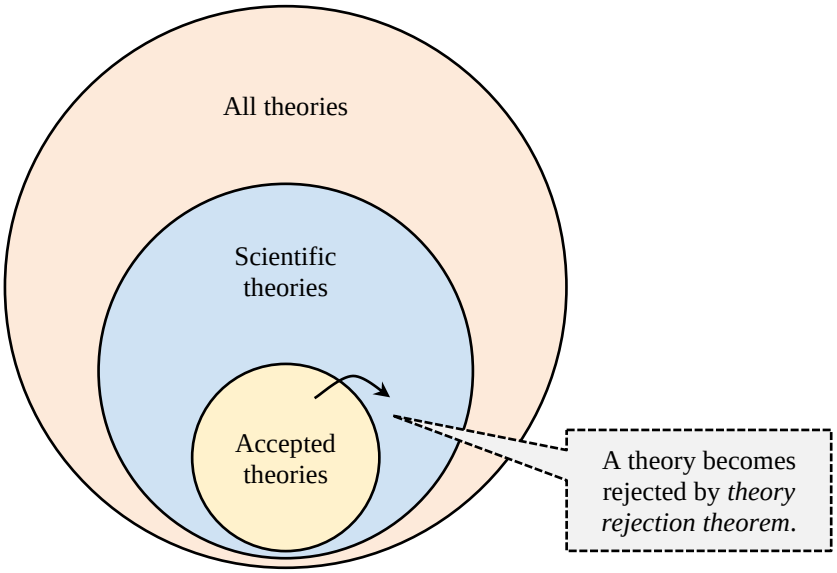


There are four pathways through which a theory may become accepted in the scientific mosaic. The outcomes are listed in the *logical* order of the criteria, i.e., first demarcation, followed by acceptance. We highlight only those outcomes that can ultimately yield the acceptance of a scientific theory. The only necessary condition for a theory to become part of a mosaic is to somehow be considered as scientific and accepted, regardless of whether or not the criteria were conclusively satisfied or were inconclusive in the first place. All theories that become accepted must be scientific, but not all scientific theories become accepted. Once the theory has satisfied the demarcation criteria, its satisfaction of the acceptance criteria leads to the following outcome:



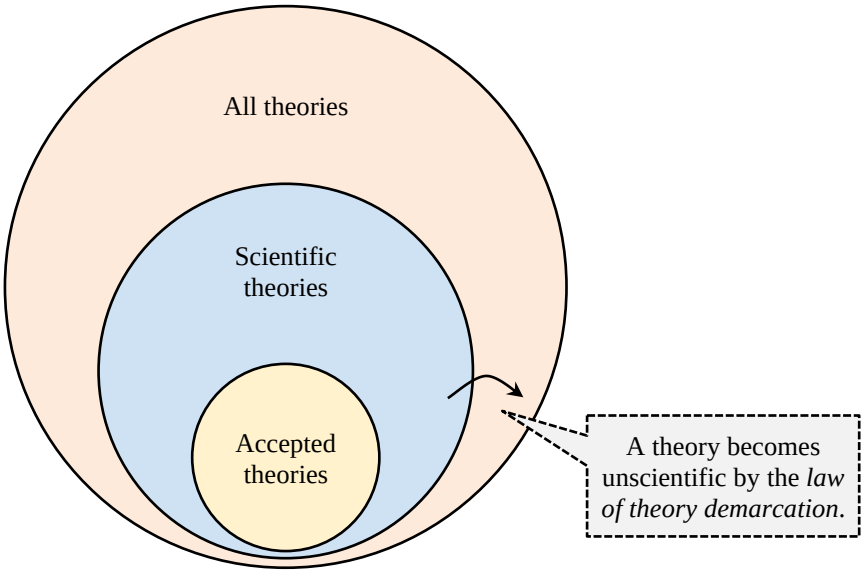
Once a new theory is accepted, it is, in light of the compatibility criteria of the time, either compatible with every single element, or it is incompatible with at least one other element of the scientific mosaic. In the former

case, nothing takes place per the *law of scientific inertia* (Barseghyan, 2015, pp. 123-129). In the latter case, the element is rejected per the *rejection theorems* (Barseghyan, 2015, pp. 165-172). Compatibility functions, as it were, to 'reverse' the process of theory acceptance, as shown by the diagram:

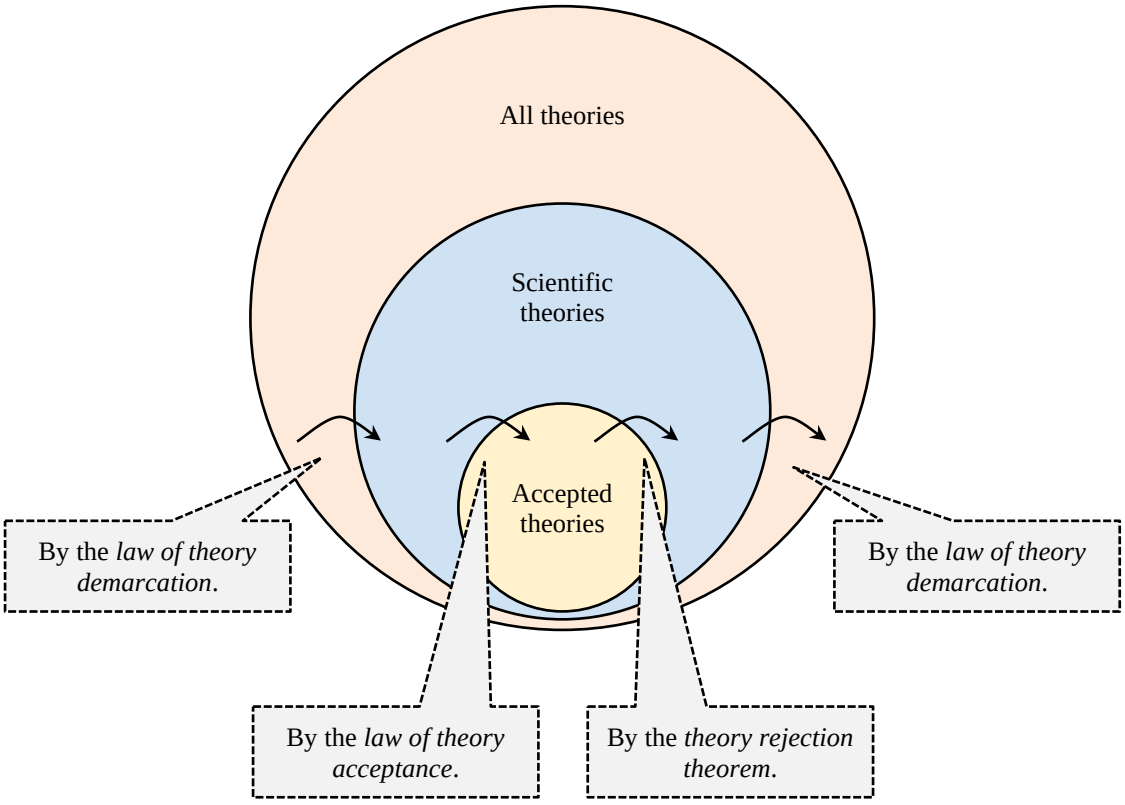


Suppose the rejected element is a theory. Its scientificity may or may not change; if it does change, this constitutes a scientific change which happens outside of a mosaic, and such change is not explicable in terms of compatibility. The explanatory capacity of compatibility is exhausted by the mutual coherence of elements in a scientific mosaic and by the rejection of elements. Suppose that the theory is reassessed by the demarcation criteria, and it is then considered unscientific. In this instance, there are only two possibilities. The first possibility is that the outcome of the initial assessment was inconclusive, in which case it is possible that, upon reassessment, the result could differ while the demarcation criteria remained unchanged. The second possibility is that the initial assessment was conclusive, in which case, in order for the result to differ upon reassessment, it is necessary that the criteria changed in the interim.

It would be interesting to see the impact of the compatibility criteria changing over time. If they change during, say, the acceptance of a theory, then an element that previously would have been rejected per the prior compatibility criteria may not be rejected in light of the newer one.



From the preceding discussion, we may see that the laws of demarcation, acceptance, and compatibility sufficiently explain any and all states a theory may obtain and transitions it may undergo. Consider the collated diagram:



If a theory is in the outermost layer (i.e., the theory is unscientific), the only region it can transition into is the region of scientific theories. No theory in the outermost region can undergo any other transition. This is explained by the *law of theory demarcation* (Sarwar & Fraser, 2018). Fulfilling this requirement is necessary but not sufficient for acceptance into the mosaic.

A scientific theory (in the second layer) can undergo two possible transitions: it may become unscientific or it may become accepted. The theory may become unscientific because the demarcation criteria can change or because the initial assessment was inconclusive. The transition of this (scientific) theory to the set of accepted theories (the innermost layer) is explained by the *law of theory acceptance* (Patton, Overgaard, & Barseghyan, 2017). Now the theory is in the scientific mosaic. (Depending on the compatibility criteria, this inward transition may lead to the rejection of some element(s) in the mosaic.)

The only transition from the mosaic is outward, viz. the theory may become rejected if at least one new element incompatible with the theory becomes accepted. This transition is explained by the *law of scientific inertia*, and therefore, by the *rejection theorems*.

Conclusion

The *law of theory demarcation*, the *law of theory acceptance*, and the *law of compatibility* are sufficient to explain any and all states a theory may obtain and all state-transitions it may undergo. For a given epistemic agent, accepted theories are a subset of scientific theories, which are themselves a subset of the set of all theories. Upon assessment, an unscientific theory becomes scientific if and only if the conditions of the *law of theory demarcation* are met. Upon assessment, an unaccepted scientific theory becomes accepted if and only if the conditions for the *law of theory acceptance* are met. Upon assessment, an accepted theory becomes rejected if and only if the conditions for the *theory rejection theorem* are met. Finally, upon assessment, an unaccepted scientific theory

becomes unscientific if and only if the conditions for the *law of theory demarcation* fail to be met. Given the explanatory potential this framework presents, we encourage scientonomists to devote resources in applying it to historical cases, thereby arming scientonomy with explanatory capacity that it currently lacks. Furthermore, research in applications of this framework to other epistemic elements, i.e., methods and questions, may prove fruitful.

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We are indebted to Hakob Barseghyan and Paul Patton for their helpful suggestions and comments on this paper. We are also thankful for the excellent suggestions made by the anonymous reviewer.

Suggested Modifications

Thus, we suggest the following modifications:

[Sciento-2018-0015]

Accept the following definition of compatibility:

- *Compatibility* ≡ the ability of two elements to coexist in the same mosaic.

Compatibility ≡
The ability of two elements to coexist in the same mosaic.

Also accept the following corollary:

- *Compatibility Corollary*: at any moment of time, the elements of the scientific mosaic are compatible with each other.

Compatibility Corollary
At any moment of time, the elements of the scientific mosaic are compatible with each other.

Accept that all theorems that take the current *zeroth law* as their premise are recoverable when the *compatibility corollary* is used as a premise instead.

Reject *the zeroth law*.

[Sciento-2018-0016]

Accept *compatibility* as a distinct epistemic stance that can be taken towards epistemic elements of all types. Also accept that compatibility is binary, reflexive, and symmetric. Transitivity of compatibility holds only within mosaics, not *sui generis*.

[Sciento-2018-0017]

Accept the following definition of *compatibility criteria*:

- *Compatibility Criteria* ≡ criteria for determining whether two elements are compatible or incompatible.

Compatibility Criteria ≡
Criteria for determining whether two elements are compatible or incompatible.

Reject the previous definition of *compatibility criteria*.

[Sciento-2018-0018]

Accept the following *law of compatibility* as a scientonomic axiom:

- *The Law of Compatibility*: if a pair of elements satisfies the compatibility criteria employed at the time, it becomes compatible within the mosaic; if it does not, it is deemed incompatible; and if assessment is inconclusive, the pair can become compatible, incompatible, or its status may be unknown.

The Law of Compatibility
If a pair of elements satisfies the compatibility criteria employed at the time, it becomes compatible within the mosaic; if it does not, it is deemed incompatible; and if assessment is inconclusive, the pair can become compatible, incompatible, or its status may be unknown.

[Sciento-2018-0019]

Accept the new definition of theory acceptance:

- *Theory Acceptance* ≡ an accepted theory is a scientific theory that is taken as the best available description or prescription of its object.

Theory Acceptance ≡
An accepted theory is a scientific theory that is taken as the best available description or prescription of its object.

Reject the previous definition of *theory acceptance*.

[Sciento-2018-0020]

Accept the following theorem:

- *Demarcation-Acceptance Synchronism theorem*: every theory that becomes accepted satisfies the demarcation criteria employed at the time of acceptance.

Demarcation-Acceptance Synchronism theorem
Every theory that becomes accepted satisfies the demarcation criteria employed at the time of acceptance.

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