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MIRACLES WITHOUT VIOLATION: SYSTEMS AND CONSTRAINTS

Abstract. Suppose that God brings about a miraculous event: the Sun is halted in its course, the Red Sea is parted, a man walks unaided on water. Prescinding from the epistemological question of how one may know that a particular event is miraculous, we may instead ask how miracles can occur without disruption of the laws of nature. This latter question, of course, depends on the nature of reality itself. Are the laws of nature absolute and fixed? If so, would a miraculous event constitute a violation of those laws? Or perhaps the laws of nature are not fixed, but permit exceptions or probabilistic deviations, in which case no violation would seem to occur? This paper develops a conceptual model to explain how miracles may occur in accordance with, and without violation of, nature's laws. It begins with the traditional understanding of miracles as events contrary to nature, followed by an examination of David Hume's influential account of miracles as violations of the laws of nature. A number of objections to Hume's position are then considered, including accounts that seek to understand miracles in terms of divine agency, suspension, or causal intervention. It is argued, however, that these objections fail to resolve the matter entirely and that the underlying problem remains conceptually unresolved. To reframe the debate, the paper examines the distinction between open and closed systems and thereafter introduces the concepts of systems and constraints. A system is understood as a set of states of affairs governed by constraints, illustrated through the simple game of tic-tac-toe. Within this framework, a miracle is understood as an act of God that temporarily modifies the operative constraints of the natural system, thereby permitting states of affairs beyond those ordinarily admissible. Such an alteration neither abolishes nor suspends the natural order, but instead temporarily extends it. In this way, the account seeks to preserve both the integrity of nature's laws and the efficacy of divine action. The paper concludes with a summary and brief reflection on the broader implications of the argument.

Keywords: miracles; laws of nature; constraints; systems; states of affairs; natural order; Divine action

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1. DEFINING MIRACLES

During the fourth watch of the night (3-6 am), he came toward them, walking on the sea. When the disciples saw him walking on the sea they were terrified. "It is a ghost," they said, and they cried out in fear. At once Jesus spoke to them, "Take courage, it is I; do not be afraid." (Matthew 14:25-33)

If any event can be characterized as miraculous, then Christ's act of walking on water certainly qualifies as one. Aside from the miraculous event itself, what might capture the reader's attention is the reaction of the Apostles. According to the testimony of the gospel writer, they were overwhelmed with fear upon seeing the figure in the distance, initially mistaking Christ for a ghost. Such a reaction is entirely understandable. Witnessing a man apparently defying the laws of nature would be a remarkable, if not terrifying, experience—an authentic spectacle deserving the appellation "miraculous".

Etymologically speaking, the term "miracle" is rooted in the Latin *miraculum* which is related to *admiratio*, in the sense of an object of wonder (Aquinas, 1947).[1] However, not all wondrous events may be classified as miracles. Two examples should illustrate this point. On April 14th, 1982, Tony Cavallo was working on a 1964 Chevrolet when the jack suddenly slipped, trapping him beneath. Upon seeing this, his 50-year-old mother Angela Cavallo lifted the car and held it up until help arrived to save her son (Anonymous, 1982). For another example, on May 24th, 2008, a Florida woman, Velma Thomas, was pronounced clinically dead from a heart attack only to unexpectedly awaken more than 17 hours later (Anonymous, 2008). Certainly, these events are wondrous. But such acts would not be classified as miracles. According to St. Thomas Aquinas,

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1 "Respondeo dicendum quod nomen miraculi ab admiratione sumitur... Miraculum autem dicitur quasi admiratione plenum, quod scilicet habet causam simpliciter et omnibus occultam." See, *Summa Theologiae* I, q. 105, a. 7.

> [I]t is not enough for a miracle if something is done outside the order of any particular nature; for otherwise anyone would perform a miracle by throwing a stone upwards, as such a thing is outside the order of the stone's nature. So, for a miracle it is required that it be against the order of the whole created nature. But God alone can do this, because, whatever an angel or any other creature does by its own power, is according to the order of created nature; and thus, it is not a miracle. Hence, God alone can work miracles.[2]

From the above description, amazing feats of strength, revivals from the death, and similar events would not be defined as miracles unless they are attributed to a supernatural cause.

What about events potentially caused by other kinds of supernatural agents, such as the movement of objects by ghosts or angels? Here we have a supernatural cause. Would such events be miraculous? Again, the answer is 'no'. Referring back to Aquinas, a miracle is such that it is "against the order of the whole created nature". Any person can cause a stone to rise (against gravity) into the air. However, to walk on water, halt the course of the Sun, rise from the dead, and so on, are completely contrary to nature.[3] For such feats, only God can rightly be called the cause.[4]

Miracles may therefore be defined according to three criteria. A *miracle* is an event:

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2 See, *Summa Theologiae* I, q. 110, a. 4.

3 There are examples in Hindu literature of miraculous-like events, e.g., "Brahmin called Vasudeva who had leprosy. He heard that Caitanya was visiting his village and went to the house where he was staying where the master embraced him. At the touch of Caitanya the leprosy fled away with his sorrow, and now full of joy his body became beautiful" (Flood, 2011, 193).

4 If we broaden this condition, the term 'miracle' could be attributed to any supernatural cause, whether Divine or Angelic. See (Larmer, 2013, 33) for a more in-depth discussion.

1. that is contrary to nature,
2. that can only be attributed to God, and,
3. that evokes wonder in those who bear witness to it.[5]

2. MIRACLES AS VIOLATIONS

The central question examined in this paper follows from the first criterion, which suggests that miracles are *contrary* to nature. In what sense can a miracle be said to be "contrary" to nature?

In one sense, an event or action is contrary to another insofar as it *interferes* with an intended end—as a sports fan who runs onto a ball field during gameplay. For example, Bernard Boedder states that "no event is called a miracle, unless it be due to quite a special interference of God" (Boedder, 1891, 412-413). In like fashion, C.S. Lewis remarks that a miracle is an "interference in the natural order by the supernatural" (Lewis, 1947, 5).

Closely connected to the concept of interference is the notion of *suspension*. In this view, God suspends or temporarily sets aside nature's laws, e.g., so that a man can walk unaided on water. A suspension is similar to an interference insofar as some law of nature is temporarily withheld, in this case, the law of gravity.[6]

According to a third sense, we speak of an event or action as contrary to another insofar as there occurs some transgression or *violation*—a driver who unlawfully passes through a red light. It is in this latter sense, moreover, that David Hume defines a miracle in Section X of An *Enquiry Concerning Human Understanding* as "a violation of the laws of nature" (Hume, 1993, 76). As violations, Hume

5 We add this third condition because , by definition, a miracle is a phenomenon that occurs before a witness or group of witnesses. On other accounts, miracles are defined by their occurrence within the context of a religious tradition (Holland, 1965).

6 Pope John Paul II stated that, "Miracles are not in opposition to the forces and laws of nature, but constitute only a certain experimental 'suspension' of their ordinary function, not their annulment" (Anonymous, 1988).

continues, miracles run contrary to the normal course of uniform experience. Consequently,

> [A]s a uniform experience amounts to a proof, there is here a direct and full proof, from the nature of the fact, against the existence of any miracle; nor can such a proof be destroyed, or the miracle rendered credible, but by an opposite proof, which is superior (76).

As violations, miracles constitute breaches or transgressions of the uniform norms of nature and experience. Consequently, for Hume, belief in miracles is unjustified, since the very concept of a miracle entails a violation of those norms.

But have we arrived at a complete account of the miraculous? Does the expression "contrary to nature" imply a violation of the laws of nature? What, moreover, does it mean to speak of a miracle as a violation? A jazz musician improvises upon a standard: does the musician thereby violate the standard? Or does the musician temporarily introduce a variation instead, after which the music resolves back into the original standard itself? Similarly, does God interfere with nature, violating its laws in bringing about what is contrary to it? Or does He temporarily extend those laws instead? In what follows, I seek to develop an account of miracles as "contrary" to nature in this latter sense.

3. OBJECTIONS TO HUME

Even if miracles are understood as violations, Hume's conclusions do not necessarily follow.[7] For example, in *The Concept of Miracle* (1970), Richard Swinburne defines a miracle as "a violation of a law of nature

7 For an overview of the positions on this issue, see (Araujo, 2017; Aguti, 2016; Mavrodes, 1985; Berkovitz, 2012).

by a god" (Swinburne, 1970, 13). Unlike Hume, however, Swinburne does not regard this account as providing sufficient grounds for rejecting the likelihood of miracles. The issue instead becomes one of determining under what conditions an event may reasonably be regarded as miraculous rather than merely anomalous or random.

Miracles understood as violations are also problematic for the relationship between miraculous events and God as their divine author. Civilians must stop before traffic lights and stop signs. In contrast, emergency and law enforcement vehicles are not required to do so under emergency conditions. It would be mistaken to suggest that such vehicles "violate" those laws, since in such cases they are not subject to them. Likewise, as God is not subject to the laws of nature but is their author, the language of "violation" appears imprecise.

As David Corner suggests in *The Philosophy of Miracles* (2007), it is improper to conceive of God as a supernatural cause in the same way and sense in which we speak of an efficient agent operating in nature. Divine acts are better understood as *basic acts*, that is, acts performed directly and not through an intermediary mechanism, much like bending one's finger as opposed to flipping on a light switch. As a basic action, God does not cause miracles so much as perform them.[8] Consequently, on Corner's account, divine action need not be understood as causally interfering with nature in the manner of an external efficient force.

From another point of view, in *The Legitimacy of Miracle* (2014) Robert Larmer argues that miracles should not be understood as violations or suspensions of the laws of nature at all. It is essential in this context to distinguish between the laws of nature versus the material conditions under which events unfold.[9] Newton's laws

8 "My commitment is to the claim that, if we conceive miracles as basic actions on the part of God, we do not have to think of God as bringing them about in an event-causal sort of way" (Corner, 2007, 87).

9 Cf., Larmer, 2013, 37-46.

of motion, for example, do not explain or produce the movement of billiards balls; rather, they describe the patterns according to which motion occurs once the relevant causal and material conditions are in place. To predict what happens on a billiards table, one must also know the number and position of the balls, the angle of impact, the condition of the felt, and so on. Thus, if an additional causal factor were introduced (another ball is placed on the table), the resulting motion would differ from what might have otherwise occurred, yet no law of motion would thereby be violated. In like fashion, God's miraculous acts may alter the material conditions of nature, producing events beyond the ordinary course of physical systems without either suspending or violating those laws.

4. PROBLEMS WITH THE OBJECTIONS

Despite these accounts, several issues remain. First, there is the problem of accounting for what might be called the *coincidental effects* of miracles.[10] Whether divine agency is understood as supernatural causation or minimally as a basic action, as Corner suggests, whatever God enacts in the world would produce effects throughout the natural order. The parting of the Red Sea, for example, would not merely impact the divided waters themselves, but also surrounding currents, pressure systems, marine life, and broader environmental systems. According to many contemporary approaches in physics, physical systems are frequently understood as highly interconnected, such that localized changes may have wider systemic implications (Holovatch *et al.*, 2017). From the point of view of coincidental effects, miracles may appear as violations or disruptions of the whole course of nature, particularly as they originate from a supernatural source.

Second, Larmer's distinction between the laws of nature and the material conditions shifts the discussion of violations from

10 For more on the impact of miracles on causal structures, see Luck (2016).

the states of affairs that can *possibly* occur in a system to the states of affairs that *actually* occur in it. Yet the core problem, as argued in this paper, concerns the former. The difficulties relate to what are here called the *constraints* (rules, norms, laws) of a system.[11] In the game of chess, for example, it is permissible for a bishop to move diagonally across rows and columns, but not horizontally or vertically. To do otherwise would violate the constraints (here, the rules) of the game.

This applies to moves that may appear valid during gameplay (the material conditions) but are not. One constraint of chess is that players must move in turn. A pawn can permissibly be moved forward into an empty square, but *only* during the player's turn. If material conditions were the only factor relevant to assessing the results of gameplay—that a piece is moved from position b2 to b3, whether it can now be captured, and so on—then following Larmer's account, no violation of the constraints of the game will have occurred. But no one familiar with the rules of chess would submit to a player's piece being moved by their opponent.

In like fashion, the addition of a causal factor within a system does not of itself resolve the question of whether the constraints governing that system have been preserved. If a falling object is caught by a person, the law of gravity is not violated because the event remains consistent with the ordinary constraints governing interactions between bodies within the natural system. In contrast, if a falling object were suddenly suspended in place without any intermediary physical condition sufficient to account for the event, the issue is no longer simply one of an additional causal influence entering the system. Rather, the question becomes whether the ordinary constraints governing what can occur within that system have themselves been overridden.

In the end, the question of whether miracles interfere with or violate the laws of nature remains unresolved. Part of the difficulty

11 These notions are developed in Section 6 of this paper.

concerns our understanding of God as a supernatural agent and the nature of divine agency itself. Another concerns our understanding of nature and the status of the laws and conditions said to govern it. Depending on one's view of the natural order, miracles may appear either as events permissible within a more flexible framework or as violations of an otherwise fixed system. The next section examines this broader division in terms of the distinction between open and closed systems.

5. OPEN AND CLOSED SYSTEMS

Philosophical talk of open and closed systems finds its origin in thermodynamics. A closed system is defined as one for which, "matter never crosses the system boundaries, though energy may do so". Alternatively, in an open system "matter as well as energy crosses the control surface" (Babits, 1963, 4). Thus, whereas an open system permits the transfer and exchange of both energy and matter, a closed system permits only the transfer of energy.

A common example is a stovetop. With the lid removed, both heat and water vapor escape, making the system open, since energy and matter are exchanged with the environment. With the lid on, only heat escapes while water vapor is retained, making the system closed, since only energy is exchanged.

In discussions of miracles, philosophers often extend the concepts of open and closed systems to the structure of the natural order as a whole.[12] A *closed system*, in this context, is one in which the amount of matter and energy remains constant and the laws governing the system are fixed and unchanging. A classic example

12 Similar extensions may also be found in physics, though in a different context. For example, "A closed universe implies a self-contained cosmos where energy remains constant, potentially leading to an eventual collapse (Big Crunch). Conversely, an open universe allows infinite expansion, with energy and matter possibly interacting with unknown external systems (multiverse theory)" (Goshu, Ridwan, 2025, 225).

is the so-called "clockwork universe" of Newtonian physics, in which matter and energy are conserved, and the cosmos operates akin to an engineered mechanical clock whose movements are strictly governed by unchanging physical laws (Craig, 1986, 123). Since nothing may be introduced into such a system and its laws remain fixed, miracles—which historically appear both to add and to alter the ordinary conditions of nature—would be understood as violations of that system.

In an *open system*, in contrast, matter and energy need not be conserved, and the laws of nature need not be fixed but may instead be subject to variation, such that states of affairs can exhibit deviations or disruptions from ordinary patterns. A classic example is the atomistic universe of Epicurus: atoms fall through a void along predictable trajectories, yet on occasion an atom may deviate from its course and "swerve" unpredictably. The introduction of such randomness suggests that the laws governing the universe are not absolute. With each swerve, a random or probabilistic event enters the natural order.

A similar model may also potentially be identified in the modern concept of *quantum indeterminacy*. The Heisenberg Uncertainty Principle, for example, holds that the simultaneous position and momentum of particles, such as electrons, cannot be specified with exactness but are instead described probabilistically (Calosi, Wilson, 2019). It follows that, within such systems states of affairs may potentially exhibit probabilistic or seemingly random variation. On such a reading, one might argue that miraculous interventions could occur without violating nature, since such systems already permit probabilistic variation.[13]

13 Steven Horst objects: "Indeed, it is not clear that even the Copenhagen interpretation provides what is needed for miracles. It is most naturally understood as describing the universe as a closed system, but one in which causal mechanisms are probabilistic rather than deterministic. What is needed to allow for miracles, however, is a view on which the physical universe is an open system—at least, one that is open to Divine intervention. If God merely "loads the dice," as it were—choosing from among the outcomes

Summarizing the two positions: in a closed system, miracles would appear to violate the system since matter and energy remain conserved and the laws governing the system are viewed as universally fixed and unchanging. Miraculous events such as the multiplication of bread or the resurrection of the dead would therefore constitute departures from the ordinary course of nature. In contrast, in an open system miracles need not be understood as violations, since matter or energy may potentially enter the system from without, or else the laws governing the system may not be universally fixed but permit random or probabilistic states of affairs. On such a view, miracles may be regarded not as violations of nature, but as events occurring within a more flexible or incomplete natural framework.

6. SYSTEMS AND CONSTRAINTS

In what follows, an alternative model is proposed. In mathematics, distinct operations yield distinct outcomes that shape the nature of a system. Mathematicians also distinguish between different kinds of systems, such as groups and fields. Various properties follow from these distinctions, but the focus here will be on *constraints*, in the sense of the rules that govern the system.[14]

An example of a constraint is mathematical closure. Broadly defined, an operation performed on a member of a set is said to preserve *closure* if the operation results in a member of that set (Dummit, Foote, 2004, 16-17). For example, adding any two natural numbers yields another natural number, 7 + 9 = 16. Under subtraction, however,

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consistent with the wave equation by causing particular outcomes—those outcomes are no longer truly random, though they are underdetermined by the prior states and laws of QM" (Horst, 2014, 333).

14 The term 'rule' is here employed broadly to denote any law, norm, condition, etc., that may govern a system, whether axiomatic or otherwise. Its interpretation depends on the nature of the system under consideration, for instance, the explicit rules of a game versus the rules (laws, causal conditions, etc.) that govern the natural world.

this is not always the case, since 4 - 7 = -3, which is not a natural number. Thus, for the set of natural numbers addition preserves closure, whereas subtraction does not.[15]

Closure alone, however, does not define the boundaries of a system, which also include a larger set of constraints. For example, the set of integers under addition forms a group $(\mathbb{Z}, +)$. To qualify as a group, the following four constraints, including closure, are required:

$$\begin{aligned} c_1&: a + b = c && \text{[closure]} \\ c_2&: (a + b) + c = a + (b + c) && \text{[associativity]} \\ c_3&: a + 0 = a && \text{[identity element]} \\ c_4&: a + (-a) = 0 && \text{[inverse element]} \end{aligned}$$

Of course, the kinds of constraints imposed by mathematicians are pragmatic, often depending on the choice of the system under study, be it a group, field, ring, or other structures. For present purposes, mathematical constraints serve as an analogy to natural systems, where constraints take the form of laws or norms governing the natural world. Just as altering axioms or operations reshapes a mathematical structure, so altering the constraints of a natural system potentially reshapes that system. In the case of miracles, it may be supposed that God—analogous to a mathematician who revises the rules that define a formal system—alters or amends the natural constraints and may even do so without violating the original system. To see how this may be possible, miracles are examined in relation to the concept of a "system", as described below.

A *system* $\mathfrak{S}$ consists of two parts: a set of possible states of affairs (S) together with a set of constraints (C). The constraints govern

15 For other examples, neither the set of natural numbers nor the set of integers are closed under division. In contrast, both the set of rational numbers $\mathbb{Q}$ and the set of real numbers $\mathbb{R}$ (which include irrationals such as $\sqrt{2}$) are closed under division (with the exception of zero).

what may or may not occur within that system. The states of affairs constitute the possible outcomes admissible under the constraints.[16]

States of affairs consist of individuals $S = \{s_1, s_2, \ldots, s_m\}$ together with their properties and relations. Examples of states of affairs include:

s_1: Adrian is a taxidermist.

s_2: The tree is next to the pond.

s_3: Aris throws the ball to Madelyn.

In contrast, constraints $C = \{c_1, c_2, \ldots, c_n\}$ consist in whatever structures, patterns, norms, etc., that govern the occurrence of states of affairs within a system.[17] Of course, identifying such constraints would require a more complete understanding of the nature of reality itself. We may avail ourselves, however, of an indirect means of determining constraints by considering what is not (ordinarily) possible for states of affairs, e.g.,

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16 Formally, a *system* $\mathfrak{S}$ may be defined as an ordered pair (S, C), such that,
$S = \{s_1, s_2, \ldots, s_m\}$ is the set of states of affairs that occur under C.
$C = \{c_1, c_2, \ldots, c_n\}$ is the set of constraints in the system.
Each $s \in S$ may be represented as the instantiation of a j-ary relation, with $j \geq 1$. For example,
s_1: Taxidermist(Adrian) [1-place relation]
s_2: NextTo(Tree, Pond) [2-place relation]
s_3: Throw(Aris, Madelyn, ball) [3-place relation].

17 Each constraint $c \in C$ is a predicate of arity $k \geq 1$ which returns *true* if satisfied, and false if not, c: $S^k \rightarrow \{true, false\}$.
Here, $k = 1$, $c(s_1)$ evaluates a single state of affairs.
$k = 2$, $c(s_1, s_2)$ evaluates a relation of affairs.
$k = m$, $c(s_1, \ldots, s_m)$ evaluates an -tuple of affairs.
Admissible states of affairs are then those that satisfy the constraints of the system,
$S = \{s \in U | \forall c \in C, c(s) = \mathrm{true}\}$,
where U is the universe of all possible states of affairs. Hence, no state of affairs can occur within the system that is not governed by its constraints—there cannot exist an $s' \in S$ such that $c(s') = false$. Consequently, the system preserves closure under its constraints.

c_1: Dogs do not ordinarily fly.
c_2: Horses do not ordinarily engage in rational speech.
c_3: Corpses do not ordinarily return to life.
c_4: A man cannot ordinarily walk on water.

The use of "ordinarily" reflects the Latin *ordinarius,* regular, customary, and *ordo*, order, row. It signifies what belongs to the normal order and course of human experience.[18] This does not mean that exceptions are impossible, but only that if they occur, then: a. they occur under some constraint that belongs to the system, or else, b. they occur under a constraint that has somehow been added to the system, which, it will be argued, is precisely what occurs in the case of miracles.

7. TIC-TAC-TOE AS A MODEL EXAMPLE

The game of tic-tac-toe serves as an illustrative example. As is well-known, tic-tac-toe is played with two marks, X and O, placed alternately by players on a 3×3 grid and gameboard. Gameplay begins when one player places either an X or an O on a square. It continues until three identical marks align in a row, column, or diagonal, or until all squares are filled. Gameplay is governed by specific rules, here the constraints of the system, as modelled below.[19]

Let $T = (S, C)$ be a system defined for the game of tic-tac-toe.

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18 Robert Larmer identifies three senses of order, viz., causal, nomic, and regular (Larmer, 2011, 36). Were a billiard ball to suddenly pop off a table without any apparent cause, this would be considered a deviation from the causal order of nature. Likewise, the reanimation of a corpse is contrary to the rule (*nomos*) of nature that governs biological life and death. Finally, it is reported that Immanuel Kant would take daily walks in Königsberg with such precision that his neighbors synchronized their clocks to his passage (Cassirer, 1983). If for some reason Kant were late, this would violate the regularity of the pattern that typically describes these walks. Likewise, if a man were to walk unaided on water, then the regularity of the pattern that describes the laws of gravity, viz., that heavy objects sink beneath its force, would be broken.

19 A similar, though more complex system may be modeled for chess, as well as other games.

The set of constraints describes the rules of gameplay, for example:
c_1: Gameplay initiates when a mark (X or O) is placed on a square.
c_2: If an X is placed on a square, an O must thereafter be placed on a square, and vice-versa.
c_3: Marks must be placed on empty squares.
c_4: No more than one mark may be placed on a square.
c_5: No square may be overwritten.
c_6: If three of the same marks occur in a row, column, or diagonal, gameplay ends with a winner.
c_7: If all squares are filled, gameplay ends.

As a result, the set S of states of affairs that may occur under the given constraints become:
s_1: An X is placed in square (2, 2).
s_2: An O is placed in square (1, 1).
s_3: An X is placed in square (1, 3).
s_4: An O is placed in square (2, 1).
s_5: An X is placed in square (3, 1).

As s_5 satisfies constraint s_6, the game terminates.[20]

What is notable in this model is the set of states of affairs S' that are not permissible in system T.[21] The occurrence of such states of affairs would *violate* the constraints (rules) of that system, and thus of gameplay. For example,
s_1: An X is placed in square (2, 2).
s_2: An O is placed in square (2, 2), overwriting X. [violation]
s_3: An X is placed in square (1, 3).
s_4: An O is placed in square (1, 1) and in square (3, 3). [violation]

20 More precisely, since $c_6(s_1, s_3, s_5) = true$, gameplay terminates. Similar conditions apply for c_7.
21 Defined as $S' = U - S$.

As the constraints of gameplay do not permit violations, it follows that under those constraints s_2 and s_4 could not occur. However, were the rules to change (i.e., new constraints are added), then these additional states of affairs would be permissible.

8. MIRACLES AND THE NATURAL SYSTEM

A system $W = (S, C)$ is now defined for the natural world. In this case, the set of states of affairs S consists of real individuals along with real properties and relations among individuals. Alternatively, the constraints consist of real laws and causal conditions that potentially describe the natural world.[22] Under such constraints, the states of affairs familiar to everyday experience would occur, for example:

s_1: The Earth orbits the sun.
s_2: A molecule breaks down.
s_3: A seed germinates in a garden.
s_4: A bird lands on a tree.

Again, of interest is the set of states of affairs that are not ordinarily permissible in such a system, which may include the following:

s_5: Emerson leaps over the Acropolis.
s_6: A fish discusses politics with Khiona.
s_7: A dead man is restored to life.

From the above analysis, particularly, it should be apparent that miracles involve the introduction of new states of affairs that are not permitted under the normal constraints of the natural system. For

22 For the natural world, we might suppose that the set of constraints consists of something like the union of the diverse domains of such laws, viz., $C = C_{physics} \cup C_{chemistry} \cup C_{biology} \cup ... \cup C_{consciousness}$.

example, of the following two states of affairs, we would consider the first permissible, but the second impermissible under the known laws of nature:

s_8: A man walks on the road.
s_9: A man walks unaided on water.

As no known natural law permits the occurrence of the latter, it follows that s_9 violates the system.

However, during a miraculous event there is no reason to suppose that God could not *amend* the natural system W to W^+ in such a way that miraculous events become now permissible. For God may introduce a new constraint such that,

$c_{miracle}$: Gravitational conditions are temporarily reconfigured at a specific location.

This in turn permits the new state of affairs such that,

s_9: A man walks on water.

Although the amended system W^+ is not identical to W, it is nonetheless an extension of it.[23]

23 Specifically, let $W^+ = (S^+, C^+)$, with $C^+ = C \cup \{c_8\}$ and $S^+ = S \cup \{s_9\}$. We see that all states of affairs admissible in W remain admissible in W^+. While $s_9 \notin S$, we have that $s_9 \in S^+$. Hence, the new state of affairs does not violate W^+. Also, given that $S \subset S^+$, its occurrence does not in principle constitute a violation of W either.

9. SOME PROBLEMS AND CLARIFICATIONS

9.1. CLARIFYING OPEN AND CLOSED SYSTEMS

Using the concept of systems and constraints, we may further clarify the effects of miracles on open and closed systems respectively. As noted earlier, an open system is one in which matter and energy are not conserved, and the governing constraints are not universally fixed. In contrast, a closed system is one in which matter and energy are conserved, and the governing laws are fixed and unchanging.

For our model, however, we may define an open system as one for which there exists a *probability constraint*, otherwise omitted in a closed system. For example, for the above system of tic-tac-toe we may introduce the constraint that: [24]

c_0: A die is rolled by each player, with the higher number playing first.

If we let $W_{op} = (S_{op}, C_{op})$ denote the set of states of affairs for the game of tic-tac-toe under the probability constraint, and $W_{cl} = (S_{cl}, C_{op})$ denote the original system, then the former may be distinguished from the latter insofar as $C_{op} = C_{cl} \cup \{c_0\}$. In other words, an open system may be understood as a closed system with a probability constraint.

9.2. RESOLVING COINCIDENTAL EFFECTS

Of course, a miracle does not occur as an isolated event but unfolds alongside other events in the world. It may therefore be argued that, even if God temporarily amends the system the sequence of events

24 Formally, such a probability constraint c_{prob} might assign to every possible state of affairs a probability distribution for its occurrence, c_{prob}: $\forall s \in S$, $P(s) \in [0,1]$.

in a closed system is nonetheless disrupted by the coincidental effects (introduced in Section 4) of the miracle itself. For example, if the normal course of events were

$s_1, s_2, s_3, s_4, s_5, s_6, \ldots$

then the introduction of a miracle in the sequence after might result in a series of alterations (indicated with the symbol '):

$s_1, s_2, s'_3, s'_4, s'_5, s'_6, \ldots$

We see that even if the laws of nature are not violated, a miracle would potentially violate the normal course or "order" of nature.

However, this also need not be the case. For comparison, as discussed earlier the set of natural numbers is not preserved under subtraction. Yet we may introduce a constraint permitting subtraction, provided the result remains a natural number $\mathbb{N}$, e.g.,

$c_{subtrtact}$: $a - b$ is defined if $a \geq b \qquad a, b \in \mathbb{N}$

Under this constraint, 4-3=1 would be permitted, whereas 4-5=-1 would not. The additional constraint thereby permits subtraction while simultaneously preserving closure.

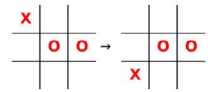
In like fashion, God may introduce constraints in such a way that the sequence of affairs is temporarily redirected during the miracle to be resolved thereafter following the miraculous event. For example, comparing the above sequence we would have instead:

$s_1, s_2, s'_3, s'_4, s_5, s_6, \ldots$

Analogously, for the game of tic-tac-toe a constraint could be added such that:

c_8: Before each turn, a player may alter the position of a marked square so long as symmetry is preserved.

Under the amended constraint, the following symmetry-preserving move would be permissible:



To an external observer, it would seem as if a rule had been broken and gameplay disrupted. Yet the impression is only apparent. Under the new constraint, the move becomes permissible. Furthermore, although the sequence of states is altered, the overall gameplay remains effectively unchanged. Were one to map the set of all possible subsequent moves in the original board to those on the symmetrical board, the mapping would be one-to-one.[25] Thus, gameplay has been altered in appearance (one might say, phenomenally), but not in essence.

In like fashion, to an observer a miracle may seem to violate not only the laws of nature but the order of nature itself. By the present model, however, this need not be the case. Following a miraculous event, both law and order are restored to the normal constraints of the natural system. A miraculous event may only *appear* to violate nature's laws, yet never truly do so—even for closed systems.

Viewing miracles as the divine introduction of a new constraint that amends and extends the possible states of affairs within a system, the above debate is resolved in several respects. When a miracle occurs, God need neither interfere with nor violate the laws of nature. Nor must we appeal to open systems to account for miraculous acts. Instead, miracles may be described as the temporal amending of the natural system by an act of God, resulting in new states of affairs while preserving closure.

25 The change is automorphic, as it preserves the original structure of the system.

10. CONCLUDING REMARKS

In this section, it is shown that conceiving miracles as the alteration or amendment of constraints of the natural system satisfies the three traditional criteria for a miracle (outlined in Section 1).

The first criterion holds that miracles are events contrary to nature. Under the present analysis this remains true, but with an important qualification: the contrariety is not between a miracle and nature as such, but between the natural versus the amended system. Miraculous events are permissible within the amended system $\mathfrak{S}^{+}$ but not in the natural system $\mathfrak{S}$. It follows that miracles are contrary in the sense of being "not in" the natural but the amended system.

The second criterion is that miracles are caused by God. That this is the case follows from the above account. God *alone* has the power to introduce new constraints into nature. God is therefore the sole supernatural cause of miracles. This can again be identified in the sequence of events that describe a miracle. Referring to the earlier examples, following a normal event (s_1), the future possibilities for the sequence of events undergoes alteration. New states of affairs (viz., s_{m1}, s_{m2}) arise that would not be possible under the ordinary order. We may in turn inquire into the *cause* of this change. As no natural cause is either possible (in a closed system) or probable (in an open system), it follows that a supernatural cause, viz., God, must be the source of the event.

Third, miraculous events are wondrous, and for two reasons. First, miracles seldom take place or at least take place during a restricted set of historical circumstances and times. Hume was in some sense right to suggest that miracles are highly improbable since their historical occurrence tends to be extremely rare.[26] But uncommon events (eclipses, earthquakes, etc.) tend to be met with wonder. This

26 As Augustine remarks: "For the governance of the whole world is a greater miracle than the satisfying of five thousand men from five loves. Yet, at the former [miracles] no one

likewise increases with the remarkableness of the event. Therefore, and second, miracles are events that appear to make possible the impossible. For what takes place during a miraculous event will be perceived as impossible under the normal constraints of nature. The miraculous event will appear to defy or even violate the normal order and states of affairs.

An event that is both uncommon and believed to be otherwise impossible will be considered wondrous to the highest degree. Now, miracles so characterized satisfy both requirements. Miracles remain uncommon (our analysis does not change the frequency of their occurrence), and their occurrence will be held to make possible the impossible. As a result, to one who witnesses a miraculous event it will appear wondrous.

By way of illustration, we may consider the allegorical themes present in the 1884 novel *Flatland* of the English schoolmaster Edwin Abbott. The novel is set in a two-dimensional realm populated by geometrical figures called "flatlanders" that include lines, triangles, and other polygons. Flatlanders believe that the two-dimensional realm is the only realm that exists, though in reality there are more dimensions. This is revealed when a sphere enters Flatland, presenting itself to a square in the form of a circle. The sphere eventually convinces the square of the existence of other dimensions.[27]

The introduction of a miraculous event into the natural world is akin to the entry of the sphere into flatland. Flatland symbolizes

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is amazed; at the latter one, men are amazed, not because it is greater but because it is rare" (Augustine, 1988, 231).

27 After failed attempts, the square is finally convinced as follows: "But now prepare to receive proof positive of the truth of my assertions. You cannot indeed see more than one of my sections, or Circles, at a time; for you have no power to raise your eye out of the plane of Flatland; but you can at least see that, as I rise in Space, so my sections become smaller. See now, I will rise; and the effect upon your eye will be that my Circle will become smaller and smaller till it dwindles to a point and finally vanishes" (Abbott, 1884, 71). Thereafter, the square attempts to convince other flatlanders of his revelation. However, his attempts ultimately fail and lead to his imprisonment.

the observable world under the normal laws of nature, and the entry of the sphere into flatland symbolizes the introduction of a new constraint by God in the case of a miracle. Just as flatlanders bear witness to the sphere as a two-dimensional circle, so too the human observer bears witness to the miraculous event according to the familiar restrictions of the natural order. The observer only sees a part of the cause (a circle, a man walking on water) but not the whole (a sphere, the act of God). Alternatively, just as the movement of the sphere through the plane of flatland appears wondrous to flatlanders, as a violation of its laws, so too the miraculous event appears to violate the laws of nature as we know and experience them.

Accordingly, the key insight of this paper is that there is a "space" for miracles within the natural order that neither violates nor sacrifices its universal character. This has been characterized in terms of the introduction by God of new constraints, which result in new states of affairs permissible under the amended system. From one point of view (closed systems), miracles are adjudicated as violations of the natural order. From another point of view (open systems), miracles do not violate nature's laws since such laws lack universal character. We can conclude that a miracle is never a violation of the laws of nature, but an act of God that temporarily extends the limits of the natural order.[28]

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28 G.W.F. Leibniz echoes these views when he states: "Now, since nothing can happen which is not in the order, one can say that miracles are as much within the order as are natural operations, operations which are called natural because they are in conformity with certain subordinate maxims that we call the nature of things. For one can say that this nature is only God's custom, with which he can dispense for any stronger reason than the one which moved him to make use of these maxims" (Leibniz, 2009, 7).

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