

# Paradox as the Engine of Strong Emergence

## *Towards a Causal Account of Ontological Novelty*

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### Abstract

The standard account of emergence distinguishes weak from strong emergence<sub>1</sub> primarily in terms of the predictability or deducibility of higher-level properties from lower-level descriptions. This paper argues that this epistemic framing obscures a more fundamental, ontological<sub>2</sub> distinction. I propose that strong emergence — the appearance of genuinely novel properties not instantiated in the constituents of a whole — is not merely unpredictable but is necessarily generated by paradox: that is, by configurations of parts that stand in relations of irreducible incompatibility while remaining bound together within a single whole. On this account, paradox is not merely a feature of our representations of emergent phenomena but is the generative condition of ontological novelty itself. I argue that this Paradox-Driven Emergence (PDE) thesis both vindicates the existence of strong emergence against eliminativist challenges and provides a positive causal mechanism absent from existing accounts. I distinguish PDE from weak emergence (driven by unrealised possibility), identify two structural forms of paradox relevant to emergence, and illustrate the thesis with examples drawn from natural number theory (Galileo's Paradox<sub>3</sub>), electromagnetism, and the murmuration of birds. I close by considering objections and by noting implications for the debate on downward causation.

*Keywords: emergence, strong emergence, paradox, ontological novelty, downward causation, Galileo's Paradox, philosophy of science.*

### 1. Introduction: The Problem of Strong Emergence

The concept of emergence has enjoyed a revival in philosophy of science and metaphysics over the past three decades. Its core intuition — that complex wholes can exhibit properties not present in, or deducible from, their simpler constituents — has proven indispensable for understanding the relationship between levels of reality: physics and chemistry, chemistry and biology, neuroscience and consciousness. Yet emergence remains philosophically contested, and the contested heart of that debate is the distinction between weak and strong emergence.

Weak emergence, as systematised by Bedau (1997), holds that a property is weakly emergent with respect to a lower level if it is derivable from that level only by explicit simulation — it is nomologically deducible in principle but computationally irreducible in practice. Most philosophers accept weak emergence as unproblematic. Strong emergence is a different matter. A property is strongly emergent if it is not even in principle deducible from complete knowledge of the lower-level constituents and their interactions. Critics such as Kim (1999) and Chalmers (2006) disagree about whether strong emergence is coherent or

instantiated, but both take the relevant contrast to be primarily epistemic: the question is whether the higher-level property is deducible, predictable, or explainable given lower-level facts.

I wish to propose a different, more fundamental framing. The epistemic question — can we predict the emergent property? — is secondary to the ontological question: what causes it to arise at all? I argue that the correct answer to this ontological question is paradox. When constituents of a complex whole stand in irreducibly contradictory relations — when they are both bound together by similarity and forced apart by incompatibility — a new whole-level property is generated as the only possible resolution of that paradox. This generation is necessary rather than merely possible: where paradox holds between bound relata, the emergent resolution must occur. I call this the Paradox-Driven Emergence thesis, or PDE.

The paper proceeds as follows. Section 2 reviews the standard taxonomy of emergence and identifies what I take to be its central lacuna: the absence of any positive causal mechanism for strong emergence. Section 3 introduces the PDE thesis and defines its central terms. Section 4 distinguishes two structural forms of paradox relevant to emergence. Section 5 develops three illustrative cases. Section 6 addresses the relationship between PDE and downward causation. Section 7 considers objections. Section 8 concludes.

## **2. The Standard Account and Its Lacuna**

### ***2.1 The Taxonomy***

The locus classicus for contemporary emergence theory is G. H. Lewes (1875), who coined the term to distinguish effects that are 'emergent' from those that are merely 'resultant' — the latter being additive consequences of their causes, the former being qualitatively new. C. D. Broad (1925) gave the distinction systematic philosophical expression, arguing that emergent laws are 'trans-ordinal': they govern relations between levels and cannot be derived from 'intra-ordinal' laws operative at the lower level alone.

Contemporary accounts generally follow Bedau's (1997) formulation of weak emergence, and treat strong emergence as the philosophically controversial residue. Chalmers (2006) argues that phenomenal consciousness constitutes a genuine case of strong emergence, while Kim (1999, 2006) maintains that strong emergence is either incoherent or epiphenomenal: if higher-level properties are genuinely novel with respect to the physical, they cannot also causally influence the physical without violating the causal closure of physics.

The most systematic recent treatment is O'Connor and Wong (2005), who distinguish 'resultant', 'weakly emergent', and 'strongly emergent' properties, and argue that strongly emergent properties are those with irreducible higher-level causal powers. This is an important move, but it leaves open what it is about certain configurations that generates such powers.

### ***2.2 The Lacuna***

What the standard account conspicuously lacks is a positive account of the mechanism of strong emergence: not merely a description of what strongly emergent properties are like, but an explanation of why they arise. This lacuna is not accidental. If strong emergence is defined in terms of the failure of deducibility, there is no positive story to tell: the emergent property is simply not derivable, and that is the end of the matter.

But this is unsatisfying as metaphysics. A complete account of emergence should tell us not just that certain higher-level properties resist lower-level explanation, but what it is about certain configurations of parts that necessitates or tends to produce novel whole-level properties. I propose that paradox is precisely that mechanism.

### **3. The Paradox-Driven Emergence Thesis**

#### ***3.1 Definitions***

I adopt the following working definitions:

A whole  $W$  is a thing composed of parts  $\{p_1, p_2, \dots, p_n\}$  that stand in relations to one another such that  $W$  exhibits properties not instantiated in any  $p_i$  taken in isolation.

A relationship  $R$  between  $p_i$  and  $p_j$  is paradoxical if and only if (a)  $p_i$  and  $p_j$  are bound together within  $W$  in virtue of some shared property or mutual dependency, and (b)  $p_i$  and  $p_j$  simultaneously instantiate properties that cannot be jointly satisfied by any single object — that is, their coexistence within a single whole generates a logical or ontological incompatibility that admits no resolution at the level of the parts themselves.

A property  $\Phi$  is strongly emergent with respect to  $W$  if and only if  $\Phi$  is instantiated by  $W$ , not instantiated by any constituent part  $p_i$ , and arises as the necessary resolution of a paradoxical relationship among the parts of  $W$ .

#### ***3.2 The Thesis***

PDE: Strong emergence is invariably driven by paradox. Specifically, a configuration of parts exhibits strong emergence if and only if the parts stand in irreducibly paradoxical relations. The emergent property is the resolution of the paradox at the whole-level — the only state of affairs consistent with the continued co-instantiation of the contradictory properties within a single bound whole.

Three features of this thesis deserve immediate emphasis.

First, PDE is a claim about ontological necessity. Where a paradoxical configuration exists, the strong emergence is not merely probable or likely; it is necessitated. The emergent property does not simply happen to appear; it must appear, given the paradoxical structure of the parts.

Second, PDE distinguishes strong from weak emergence not epistemically but causally. Weak emergence, on my account, arises from unrealised possibility: a configuration of parts admits a new combination that was always physically possible but had not previously been instantiated. Such emergence may produce novelty, but it does not produce the radical

ontological discontinuity characteristic of strong emergence. The difference between swimming and non-swimming molecules, as it were, is of a different kind from the difference between water and wetness, or between neurons and consciousness.

Third, PDE provides a criterion for identifying candidates for strong emergence: look for configurations in which parts are simultaneously bound together and in fundamental tension. The paradox must be real — a genuine incompatibility, not merely a surface-level contradiction — and the parts must be held together within a single whole rather than merely adjacent.

### ***3.3 Relationship to Existing Accounts***

PDE is compatible with, but stronger than, the standard weak/strong distinction. It vindicates the existence of strong emergence against eliminativist pressure (Kim 1999), since it provides strong emergence with a positive ontological grounding rather than leaving it as a merely negative category. It also supports the causal efficacy of emergent properties, since the emergent property is not merely supervenient on the lower-level facts but is the active resolution of a lower-level contradiction — and as such retains explanatory and causal relevance at the whole level.

PDE also relates interestingly to Hegel's dialectical logic, in which contradiction is the motor of development. The present proposal is not committed to any specifically Hegelian metaphysics, but it shares the core insight that incompatibility between bound relata is generative rather than merely eliminable. The difference is that PDE is framed as a metaphysical thesis about emergence rather than a logical thesis about concepts.

## **4. Two Structural Forms of Emergent Paradox**

Paradoxes relevant to emergence take two structural forms, which I call the Encapsulation Form and the Identity-Separation Form. These are not exhaustive, but they capture the primary cases.

### ***4.1 The Encapsulation Form***

In the Encapsulation Form, two objects with incompatible properties are held within a single encapsulating whole. The classic logical example is the Liar Paradox: the card that says 'The sentence on the other side is true' and whose reverse says 'The sentence on the other side is false.' What is distinctive of the Encapsulation Form is that the contradictory relata are mutually referential: each determines the truth-value of the other, and no consistent assignment is possible. The encapsulating whole — the card, the system — is the locus within which the contradiction is held, and it is at this whole level that a new kind of state arises: not truth, not falsity, but paradox itself as a positive ontological condition.

In natural systems, the Encapsulation Form appears wherever two opposite tendencies are held within a single system by some binding force. A murmuration of starlings is a paradigm case: each bird is simultaneously attracted to its neighbours (to maintain the safety of the flock) and repelled by them (to avoid collision). Neither tendency can win. The

emergent whole-level property — the fluid, self-organised wave behaviour of the murmuration — is the resolution of this paradox at the level of the flock. It is not predictable from the behaviour of any individual bird, and it would not arise if either tendency were absent.

#### ***4.2 The Identity-Separation Form***

In the Identity-Separation Form, two objects are of the same kind — they share all relevant type-level properties — yet are separated by their very existence as distinct individuals. The paradox here is that identity and difference are simultaneously demanded: the objects are the same in kind (which should make them indiscernible), yet they exist as distinct (which requires that they differ). The tension cannot be resolved at the level of the parts; it can only be resolved by the emergence of a new property at a higher level.

The canonical mathematical case is Galileo's Paradox. The natural numbers and the perfect squares can be placed in one-to-one correspondence (each natural number  $n$  corresponds to  $n^2$ ), yet the squares are a proper subset of the naturals: every square is a natural number, but not every natural number is a square. The paradox — that a proper subset can be equinumerous with its superset — is not resolvable within the framework of the natural numbers themselves. Its resolution requires the emergence of a new ontological kind: area, or two-dimensional magnitude. The square of a number is not the same kind of thing as the number itself; it occupies a new dimension, and it is that dimensional novelty which resolves the paradox.

This example is especially instructive because it shows that PDE is not merely a heuristic for identifying candidate cases of emergence but a positive explanation of why a new kind of thing must arise. Galileo's Paradox cannot be dissolved by any re-description at the level of the natural numbers; only the emergence of a new number-kind — with different ontological properties — dissolves it. The emergence is necessitated by the paradox, not merely associated with it.

### **5. Three Illustrative Cases**

#### ***5.1 The Emergence of Natural Numbers***

The sequence of natural numbers provides the simplest and most abstract illustration of PDE. Consider the initial condition: a state of unity — a single undifferentiated whole. Wholeness is a self-complete state, and yet the very fact of there being a whole entails the existence of something that is not the whole: a boundary, a complementary nothing. Wholeness thus paradoxically incorporates both something and the nothing that is its complement. This is not a verbal paradox; it is a structural feature of any state that is genuinely unitary and complete.

The resolution of this paradox is the emergence of twoness: the division of the whole into itself and its complement generates a second entity. But this process is iterated: twoness itself is paradoxical, since two identical units are both the same in kind (both are natural numbers, both are whole things) and different in fact (there are two of them, not one). This paradox is resolved by the emergence of threeness — and so on without termination.

On this account, the natural numbers are not merely defined by a successor function (as in the Peano axioms) but are driven into existence by successive paradox. Each new number is a necessary resolution of the contradiction inherent in the previous configuration. This is a stronger claim than the mathematical-foundationalist one: not merely that we can construct the integers by a formal procedure, but that the procedure reflects a genuine ontological pressure toward novelty.

## ***5.2 Electromagnetism***

A more directly physical illustration is offered by electromagnetic induction. When an electric current moves through a magnetic field — or a magnetic field changes in the vicinity of a conductor — a force emerges at right angles to both. This tri-directional relationship (the 'left-hand rule') is not a property of the electric field alone, nor of the magnetic field alone, nor of the conductor. It is a genuinely emergent property of the whole system.

The paradox, on PDE, is this: an electric charge in motion is simultaneously an electric phenomenon (characterised by its charge) and a spatial phenomenon (characterised by its velocity, hence its momentum and position). These two characterisations are not merely different descriptions of the same thing; they impose incompatible demands on what the object is. The resolution — the emergent force — is the new property that the whole system must instantiate in order to remain coherent. The force is not added to the system from outside; it emerges necessarily from the paradoxical coexistence of electric and kinetic properties in a single bound configuration.

This framing is consistent with the standard physical description of electromagnetic induction, but it adds a philosophical explanation of why the induction occurs: not merely as a brute nomological regularity, but as the necessary resolution of a genuine ontological tension between bound properties of a whole.

## ***5.3 The Murmuration of Birds***

The flocking behaviour of starlings — their complex, fluid group dynamics — offers a biological case that has been widely cited in emergence literature (Reynolds 1987; Cavagna et al. 2010). On standard accounts, the murmuration is weakly emergent: in principle, given sufficient computational resources and knowledge of the simple local rules governing each bird's behaviour, the flock-level dynamics could be simulated and hence predicted.

PDE suggests a different analysis. The local rules governing each bird are not merely correlated; they are paradoxical. The birds are simultaneously attracted to conspecifics (flocking instinct, predator avoidance) and repelled by them (collision avoidance, competition for space). These are not merely different tendencies that happen to be in tension; they are mutually incompatible demands on the bird's behaviour. The bird cannot satisfy both simultaneously at the level of its individual action. The emergent wave-behaviour of the flock is the resolution of this paradox at the whole level: it is a collective state in which neither tendency dominates, and both are accommodated through a continually self-adjusting whole.

On this analysis, the murmuration is not merely a complex result of simple rules but a necessary consequence of the paradoxical structure of those rules when applied to a bound collection of mutually-sensitive agents. This re-classification — from weak to strong emergence — is not merely terminological; it reflects a substantive claim about the generative conditions of the behaviour.

## **6. PDE and Downward Causation**

One of the central difficulties for strong emergence is the question of downward causation: can higher-level emergent properties causally influence their lower-level constituents? Kim (1999) argues that if they can, and if the lower level is causally closed, then the higher-level properties either reduce to lower-level properties or are causally inert. This is the exclusion argument.

PDE suggests a response. On the PDE account, the emergent property is not a separate entity hovering above its constituents and causally impinging on them from outside. Rather, it is a whole-level property that is constitutively generated by the paradox in the parts. As such, it is not in competition with lower-level causal description; it is the resolution of a tension that exists at the lower level but cannot be resolved there. The causal closure of the lower level is not violated, because the emergent property does not add new energy or new forces to the lower level; it reorganises the lower-level configuration in virtue of being its only coherent resolution.

A useful analogy is the emergence of a centre of gravity. The centre of gravity of a physical system exerts 'downward causation' on its parts — it governs their motion — yet it is not a separate entity. It is a whole-level property of the system that determines how the parts must behave in order for the system to remain coherent. The centre of gravity is not epiphenomenal; it is causally efficacious in a sense that is fully compatible with lower-level causal closure, because its causal efficacy just is the operation of lower-level forces organised into a coherent whole.

PDE extends this logic: all strongly emergent properties are causally efficacious in this constitutive sense. They are not additional causes layered on top of the lower-level causal order; they are the whole-level shape that the lower-level causal order must take in order to resolve its own paradoxes.

## **7. Objections and Replies**

### ***7.1 The Dissolution Objection***

Objection: Paradoxes, properly understood, are always dissoluble — they reflect conceptual confusion or inadequate description, not genuine ontological features. Once the right description is found, the paradox disappears, and with it the alleged need for emergent resolution.

Reply: This objection assumes that the paradoxes in question are always merely epistemic — features of our representations rather than the world. But Galileo's Paradox is

not dissoluble by re-description at the level of the natural numbers; it requires the emergence of a new ontological category (two-dimensional magnitude) to resolve. Similarly, the paradox of mutual attraction and repulsion in a murmuration is not a conceptual confusion; it reflects a genuine dual constraint on each bird's behaviour. The test of whether a paradox is genuinely ontological is precisely whether its resolution requires the emergence of a new kind of property — one not present in the parts. If it does, the paradox is not merely verbal.

### ***7.2 The Prevalence Objection***

Objection: Paradoxical configurations are extremely common — indeed, almost any complex system involves components with competing tendencies. If PDE were correct, strong emergence would be ubiquitous, which seems implausible.

Reply: Not every paradoxical configuration generates strong emergence. Three conditions must be jointly satisfied: (a) the paradox must be genuine and irreducible at the level of the parts; (b) the parts must be held together within a single bound whole — mere juxtaposition of conflicting objects does not suffice; and (c) the configuration must be such that a new whole-level property constitutes a coherent resolution. Many apparent paradoxes dissolve under one of these conditions — they are reducible, or the parts are not genuinely bound, or no coherent whole-level resolution exists. The prevalence objection mistakes the commonness of conflicting tendencies for the satisfaction of all three conditions.

### ***7.3 The Explanatory Circularity Objection***

Objection: PDE is circular: it claims that paradox generates emergence, but 'paradox' is defined partly in terms of the impossibility of resolution at the lower level — which is just the definition of strong emergence. The explanation is therefore trivially true.

Reply: The objection conflates the structural characterisation of paradox with the result of its resolution. Paradox, as I have defined it, is a configuration in which parts simultaneously instantiate mutually incompatible properties while being bound within a single whole. This characterisation does not mention emergence or higher-level properties; it is a claim about the relational structure of the parts. The claim that such a configuration necessarily generates a new whole-level property is a substantive, non-trivial thesis — it could be false. The objection would have force only if the definition of paradox already entailed that a new whole-level property exists, which it does not.

## **8. Conclusion**

I have argued that the standard epistemic framing of the strong/weak emergence distinction — in terms of predictability or deducibility — conceals a more fundamental ontological distinction rooted in the causal structure of complex wholes. The Paradox-Driven Emergence thesis holds that strong emergence is generated by configurations of parts that stand in paradoxical relations: irreducibly incompatible yet bound together within a single whole. The emergent property is the necessary resolution of this paradox at the whole level.

This thesis has several significant consequences. It vindicates the existence of strong emergence by providing it with a positive causal mechanism rather than leaving it as the residue of explanatory failure. It distinguishes strong from weak emergence not by degree of predictability but by the presence or absence of genuine paradox in the generative configuration. It supports the causal efficacy of emergent properties in a way compatible with lower-level causal closure. And it re-classifies at least some putatively weakly emergent phenomena — including the murmuration of birds and certain aspects of electromagnetic induction — as strongly emergent, when the paradoxical structure of their generative conditions is brought into view.

Much remains to be done. The relationship between PDE and the literature on self-organisation and complex systems warrants further investigation. The thesis requires more detailed development in the context of consciousness — arguably the most philosophically important candidate for strong emergence. And the ontological status of paradox itself — whether it is a feature of the mind-independent world or of our representations of it — needs sustained treatment.

Nevertheless, I hope to have established that paradox is not an embarrassment to be dissolved but a productive engine of ontological novelty — and that taking this seriously opens new possibilities for the metaphysics of emergence.

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<sup>1</sup> The term 'strong emergence' is used variably in the literature. I follow Chalmers (2006) in treating it as emergence that is not even in principle deducible from lower-level descriptions, but I depart from Chalmers in giving a positive rather than merely negative characterisation. Namely that it is creative of dimension.

<sup>2</sup> I use 'ontological' throughout to mean 'pertaining to what there is and how it is structured', as opposed to 'epistemic', which pertains to what we know or can know.

<sup>3</sup> Galileo's original presentation occurs in *Discorsi e Dimostrazioni Matematiche* (1638). For a modern philosophical treatment, see Mancosu (2009), 'Measuring the size of infinite collections of natural numbers', *Review of Symbolic Logic*, 2(4), 612–646.

## **Use of AI**

The author used AI assistance for drafting and structuring this manuscript

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