



A Law-Centric View of Emergence

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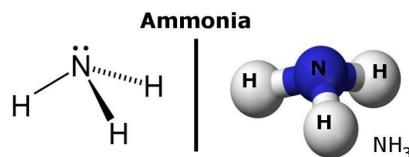
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Abstract

We seek to distinguish a "law-centric" view of ontological emergence in physics from a "mechanism-centric" view. A mechanism-centric view uses the concept of a mechanism to explain how a novel system emerges from a base system, but it's not clear how this works: can a mechanism produce phenomena sufficiently novel to be considered emergent? In this project, we distinguish between a mechanism and a law in terms of dynamics, and argue that laws provide a better account of the novelty of an emergent system than mechanisms.

Instances of Emergence

- Superconductor
- Superfluids
- Quantum Hall Effect
- Symmetry breaking
- Ammonia atom
- Mind from brain



What is a Law?

Governess – the law dictates the behavior of the system

Disposition – the apparent laws of a system are the result of the system's inherent characteristics and **Best System** - laws are only as real as our human observation of them

Equation of Motion - a mathematical expression that conveys change over time

Challenges to Law-Centrism...

- How do you reconcile conflicting views of laws across science and philosophy?
- How is a universal law identified, to prevent an infinite hierarchy of laws?

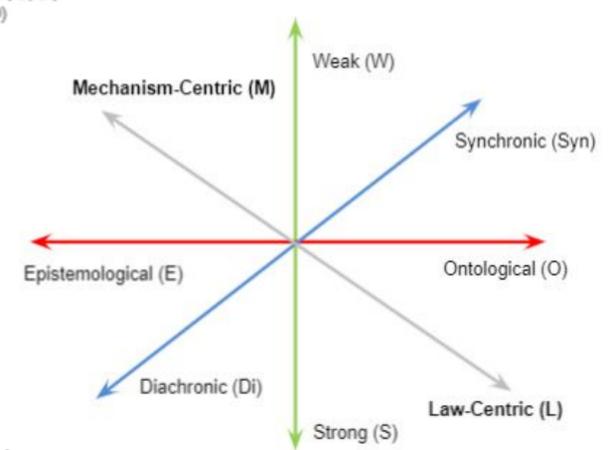
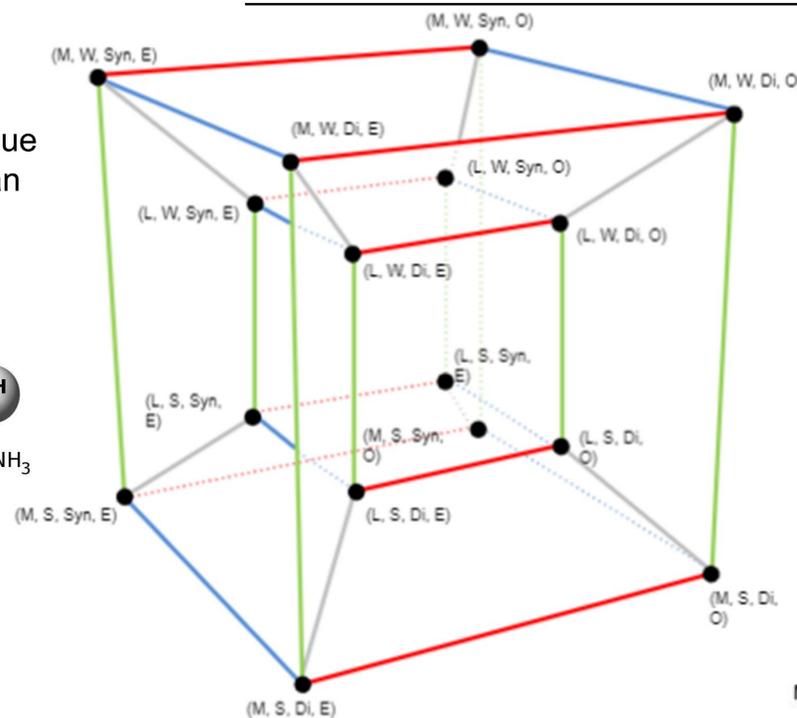
Our Defense of Law-Centrism...

- We have strictly defined laws in the sense of an equation (of motion) to balance ontological relevance with the philosophical concept of a law
- Universal Laws

Mechanism-Centrism: Emergent system is produced by a mechanism. [5], [7]

Law-Centrism: Emergent system and base system are constrained or characterized by different laws

Novelty: Unexpected new behavior in a system



The Problem of Novelty

- Main challenge to mechanism-centrism.
- At what point in the mechanical view does novelty enter?
- Is the novel behavior a part of the base system coming out, or does the mechanism create the new emergent state
- Law-centrism establishes novelty in evolution with time to the system

The Problem of Triviality

- Main challenge for law-centrism
- At what point does emergence become too blanket?
- Example: The phase transition of water into ice would be considered emergent, if symmetry breakage is to be essential to emergence

Problems with Mechanism...

- How does a mechanism *produce* novel phenomena?
- Some examples of emergent phenomena admit more than one mechanistic explanation.

Addressed by Laws...

- Laws don't *produce* phenomena; they *constrain* (government, dispositionalism) or simply *characterize* (best system) phenomena.
- In examples in which mechanisms are underdetermined, laws are not.

What is a Mechanism?

A mechanism must be a complex set of parts that create work. It can not be an individual component (such as an atom or quark), nor a loose collection of objects. It can be reduced to individual components.

Compromise

The Mechanistic and Law-Centric views of Emergence don't necessarily have to be in contention with each other. It is fair to conclude that each view simply presents different understandings and perspectives on the same things. The mechanistic view may be better suited to explaining certain ontological questions and relevancies of emergence, while a law-centric view may be better suited to broader implications of emergence.

Future Work

- Do equations of motion encode both laws and mechanisms?
- Are laws different from organizational schemes?
- Is there any connection between entropy increase and emergence?
- Add an axis of emergence that conveys horizontal vs vertical emergence?

Works Cited

[1] Anderson, P. (1972) 'More is Different', *Science* 177, 393.
 [5] Mainwood, P. (2006) 'Is More Different? Emergent Properties in Physics', PhD dissertation, Univ. Oxford.
 [7] Morrison, M. (2012) 'Emergent Physics and Micro-Ontology', *Phil Sci* 79, 141.

Acknowledgement

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