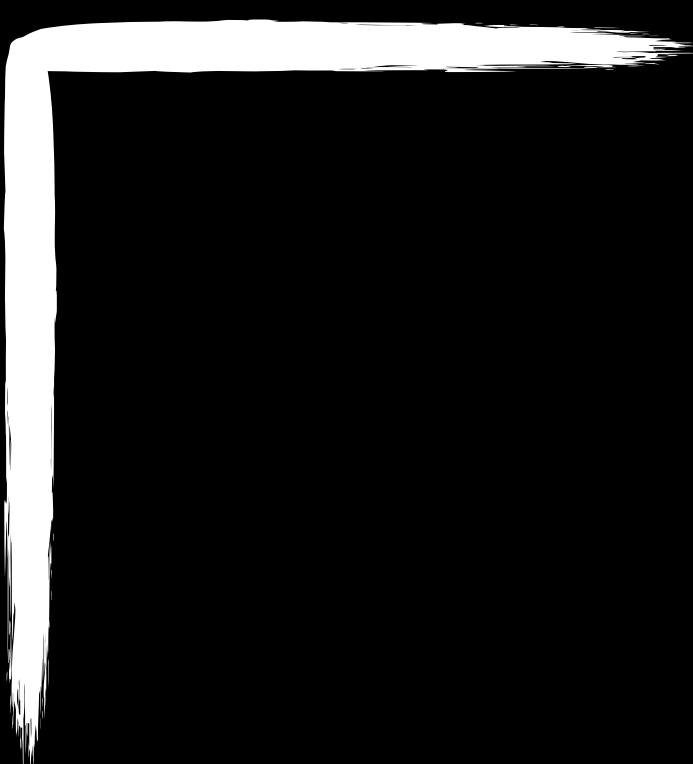
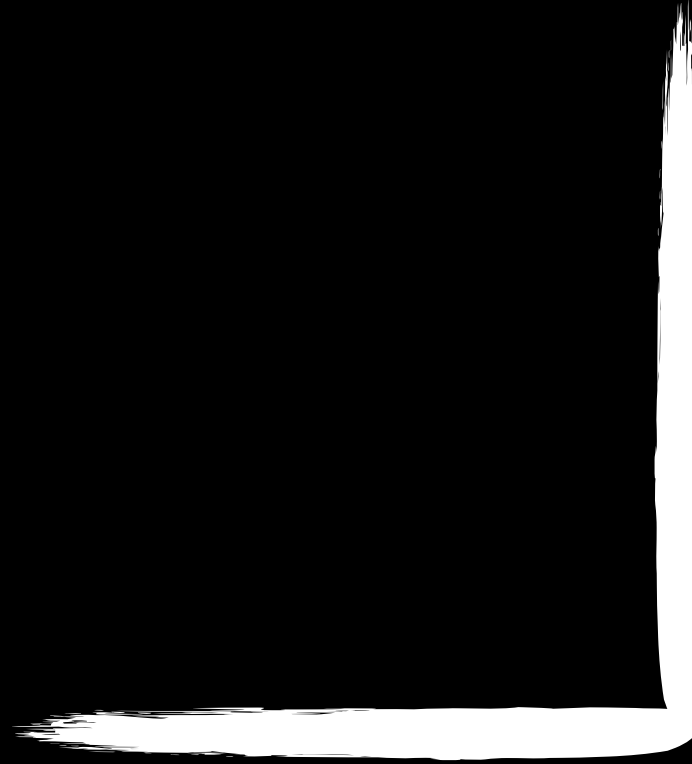


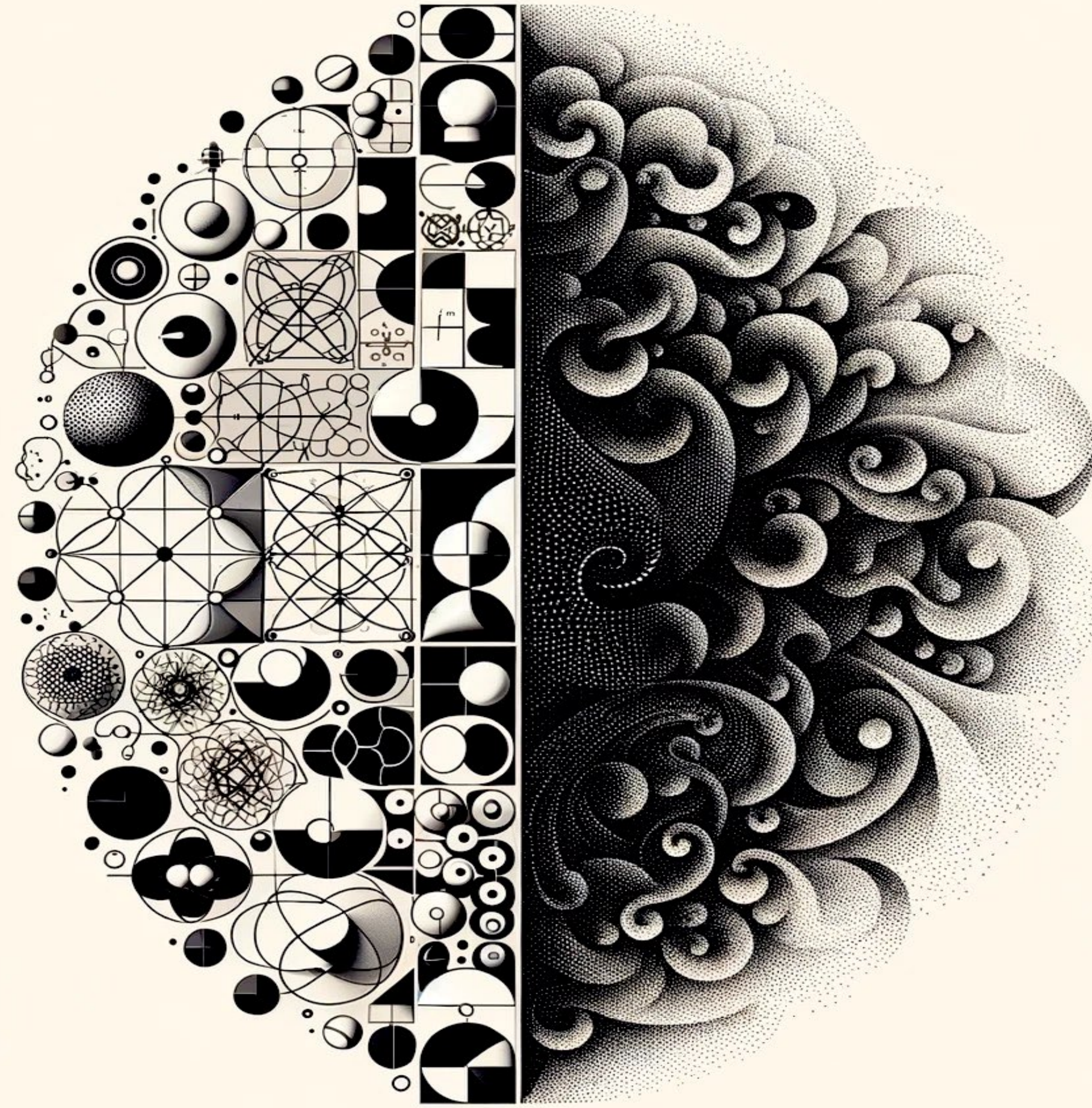


Philosophy of Science I

February 9th 2024

Session 3 - Laws of Nature





**How do we know there are laws of
nature?**



**What would be a world without
laws of nature?**

Symptoms of Lawhood



Newton's First Law of Motion (Inertia):

Any object at rest stays at rest, and any object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced external force.



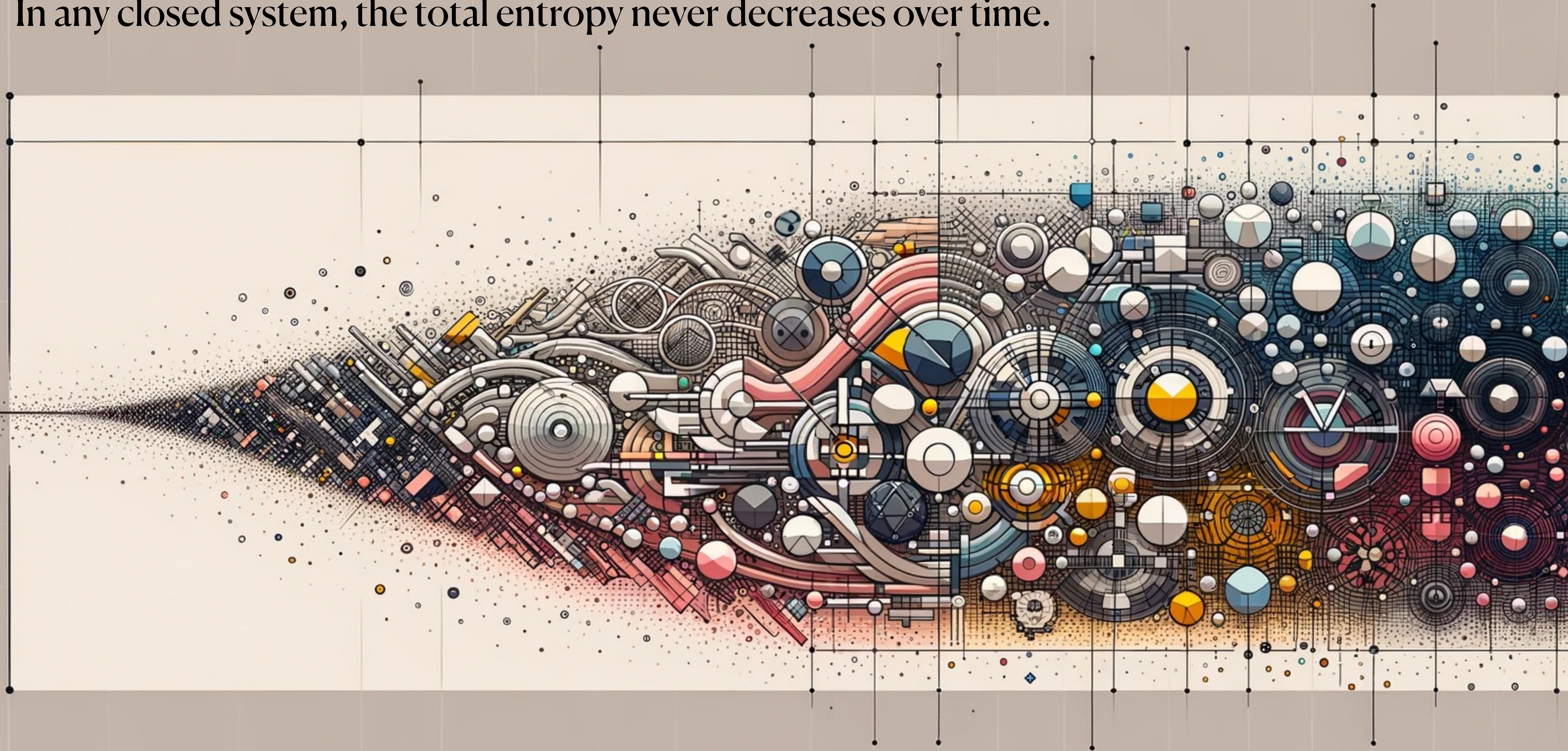
The Law of Universal Gravitation:

Any two massive bodies attract one another with a force which is proportional to the product of their mass and inversely proportional to the square of the distance between them.



The Second Law of Thermodynamics (Entropy):

In any closed system, the total entropy never decreases over time.



Evolution by Natural Selection:

When individuals within any species differ with respect to their phenotype (principle of variation), and this variation is heritable (principle of heredity), the proportions of those phenotypes in latter generations of that species will be a function of their differential fitness (principle of natural selection).



Universality

Any two massive bodies, any body, any gas, any population, any species, ...

General form of laws of nature:

- All As are Bs;
- Whenever an event of type C happens, an event of type E occurs;
- If event e happens, then invariably event f occurs;
- For all x: if x is F, then x is G.

Laws do not refer to any particularities.



But clearly it's not only about that:

- **All bachelors are unmarried.**
- **All even numbers are a multiple of 2.**

Which are not laws! It seems that laws also are true by facts of the world:

Law of nature are synthetic!

And can be true even if not currently instantiated.

Q: "Natural selection is the survival of the fittest. The fittest are those that survive". Is this synthetic?



Still, these features are not enough to tell apart **laws of nature (LoN)** from **accidentally true generalizations (ATG)**. What seems to really break the degeneracy between LoN and ATGs is a sort of **necessity** that natural laws seem to have that grant them the explanatory power: instead of a matter of factness, they instantiate a *need*, a *have to be in such and such way*.

Q: “If God wants it, then it is.”
Is this a law?



Necessity

Possibility: A statement is considered possible if it can be true in at least one scenario or world.

Necessity: A statement is necessary if it is true in **all** possible scenarios or worlds.

Q: How can we tell?



Counterfactuals

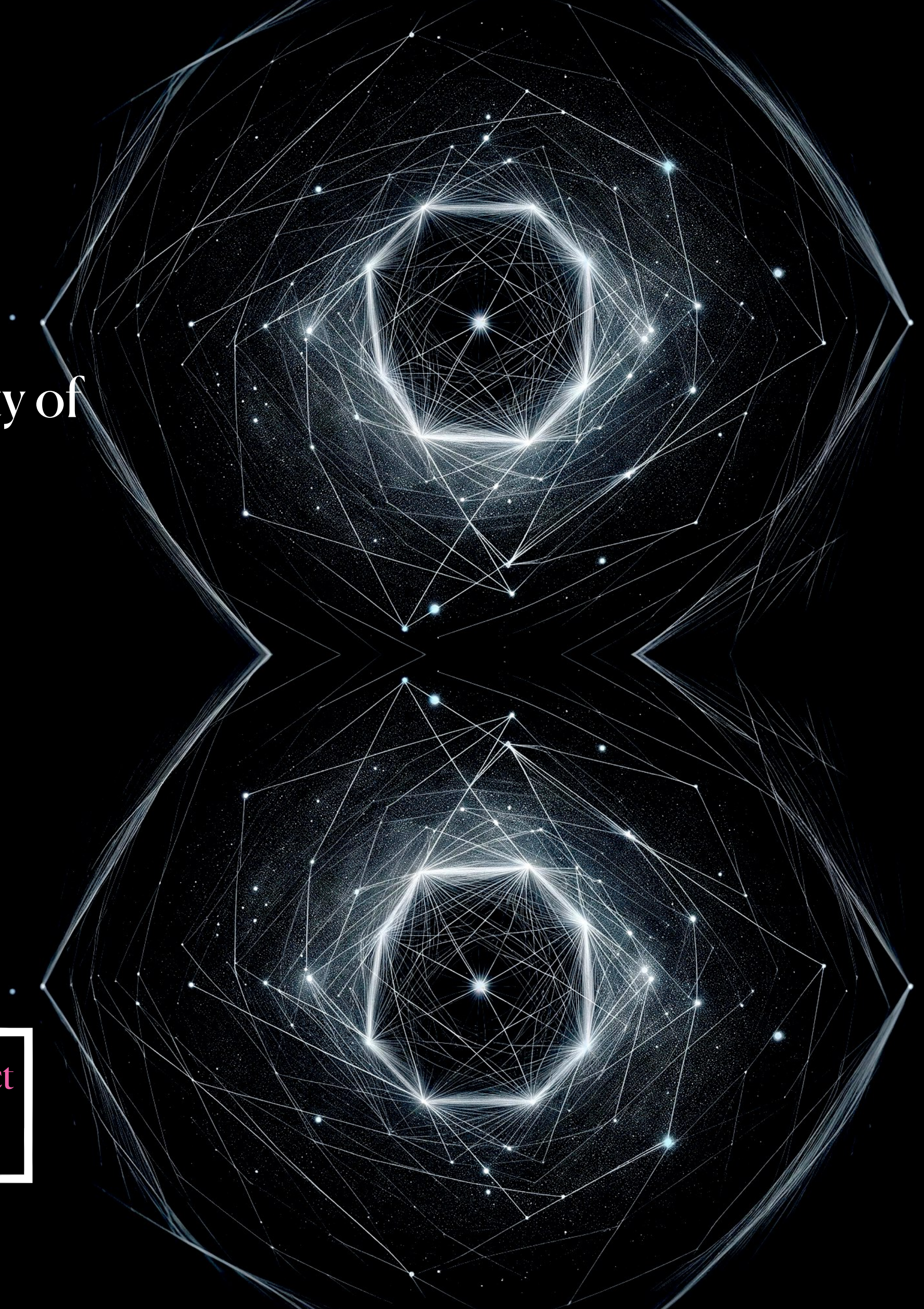
One way to make sense of what distinguishes the necessity of LoN from the contingency of ATG concerns the extent to which they support counterfactual conditionals.

A counterfactual is of the form:

If _____ were the case, then _____ would be the case.

↑
The 'antecedent' of the conditional, which is typically false

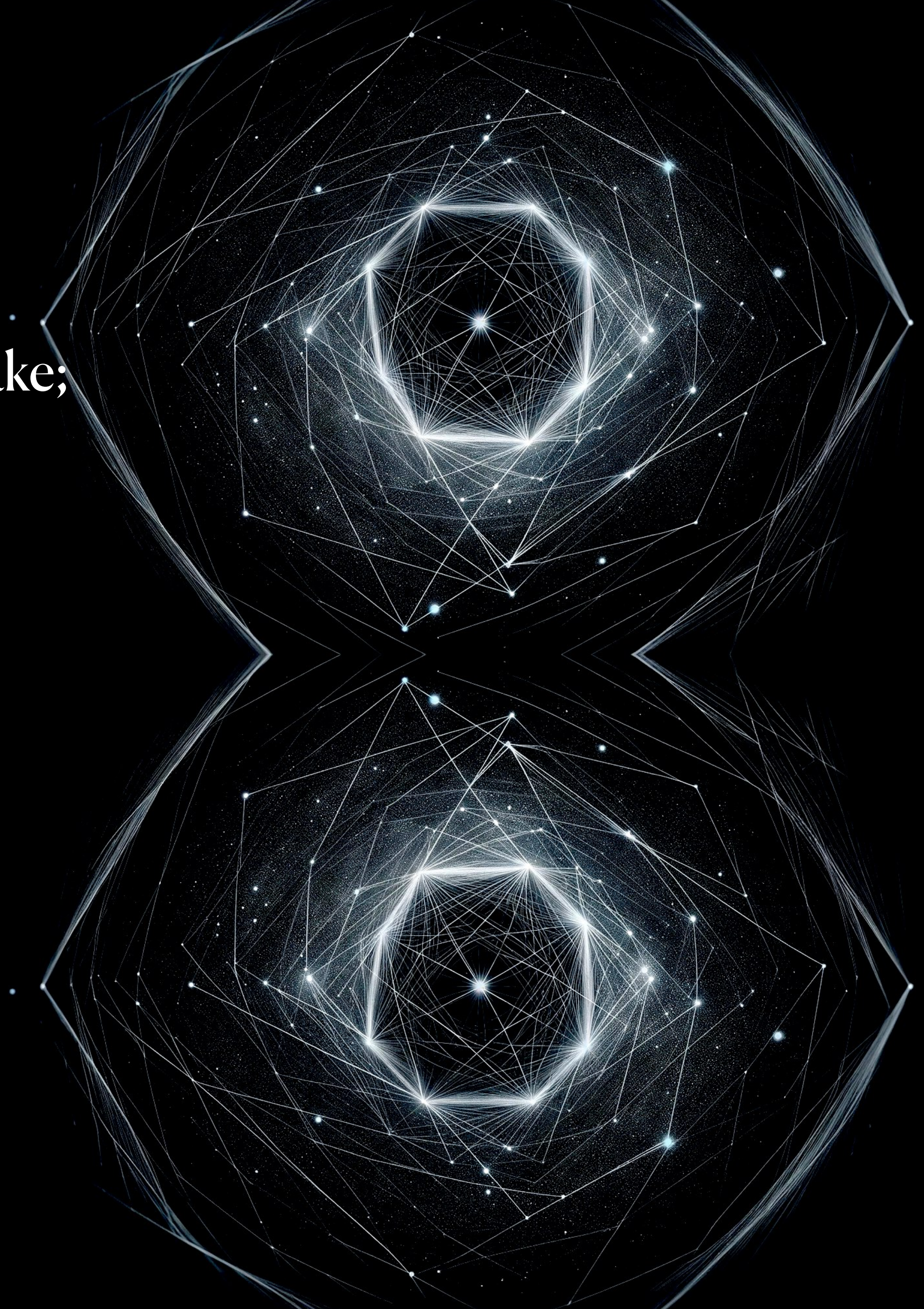
↑
But if it were true, then we would expect the 'consequent' to be true also



Examples

- If I had known you were coming, I would have baked a cake;
- If I'd missed the train, I would have been late for class.

- If the table were made of lead, it would be easy to move;
- If there were 100 students in the class, they would fit in a small classroom.



Examples

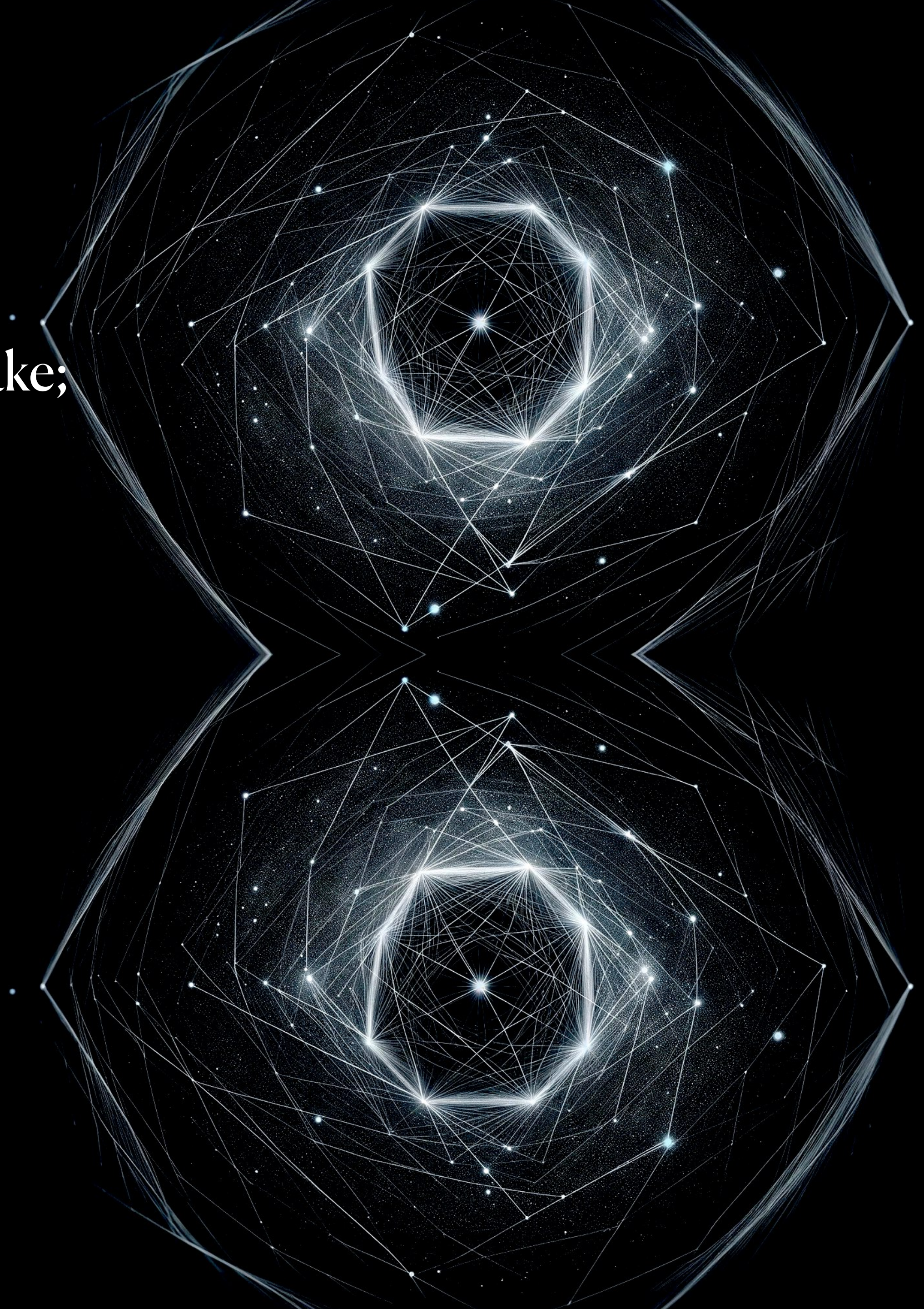
- If I had known you were coming, I would have baked a cake;
- If I'd missed the train, I would have been late for class.

These sentences seem to be **true**.

And not, just because they have false antecedents.

- If the table were made of lead, it would be easy to move;
- If there were 100 students in the class, they would fit in a small classroom.

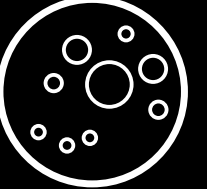
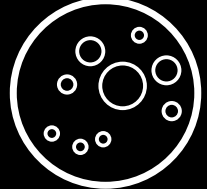
These ones seem to be **false**.



All solid masses of pure **PLUTONIUM** weigh less than 100 tons.

All solid masses of pure **gold** weigh less than 100 tons.

We believe both statements are true, but the first one out of necessity while the second one out of cosmic coincidence, since it would be possible to have such a massive gold object while it would not be possible to have it made of plutonium:

- If it were the case that the  is made of pure **PLUTONIUM**, then it would be the case that it weighs less than 100 tons. **(TRUE)**
- If it were the case that the  is made of pure **gold**, then it would be the case that it weighs less than 100 tons. **(FALSE)**

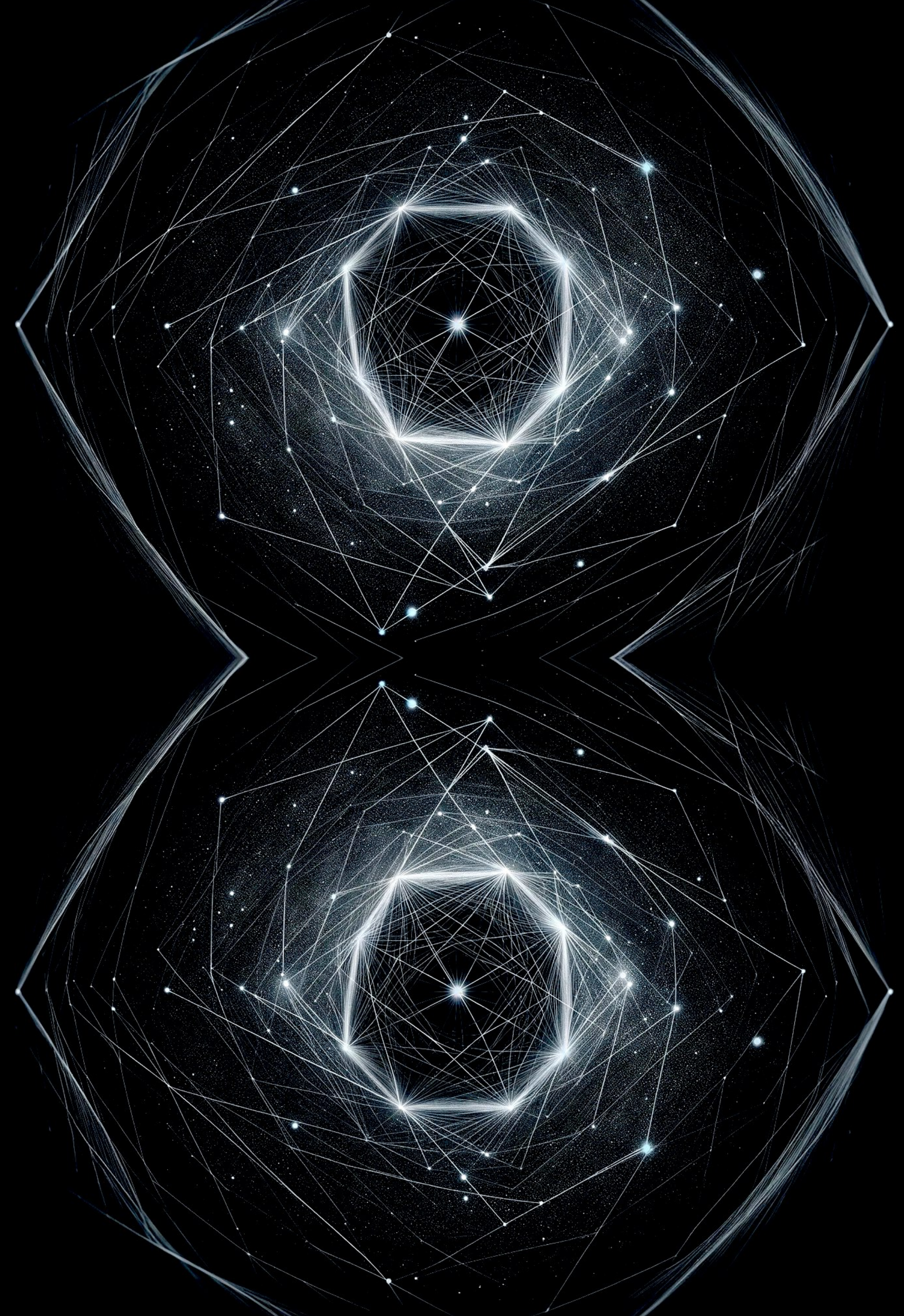


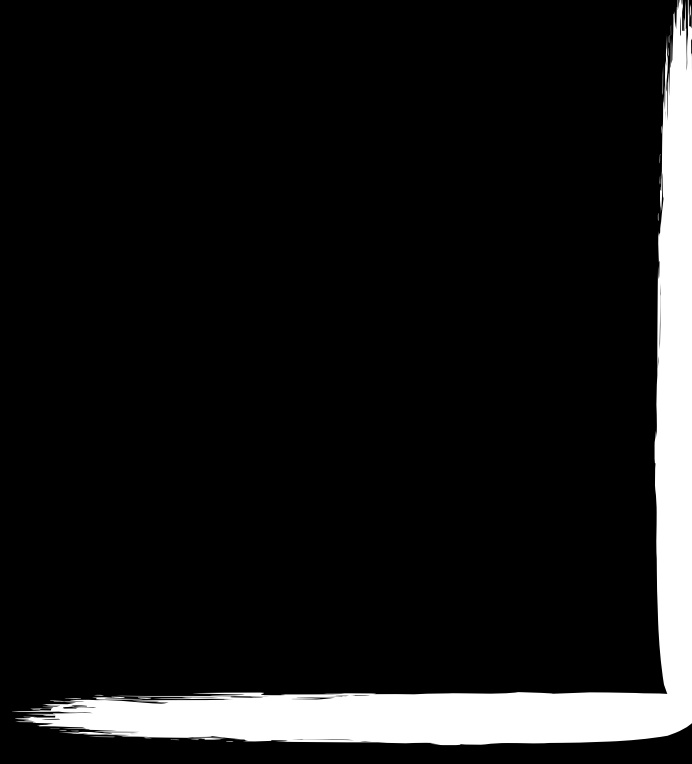
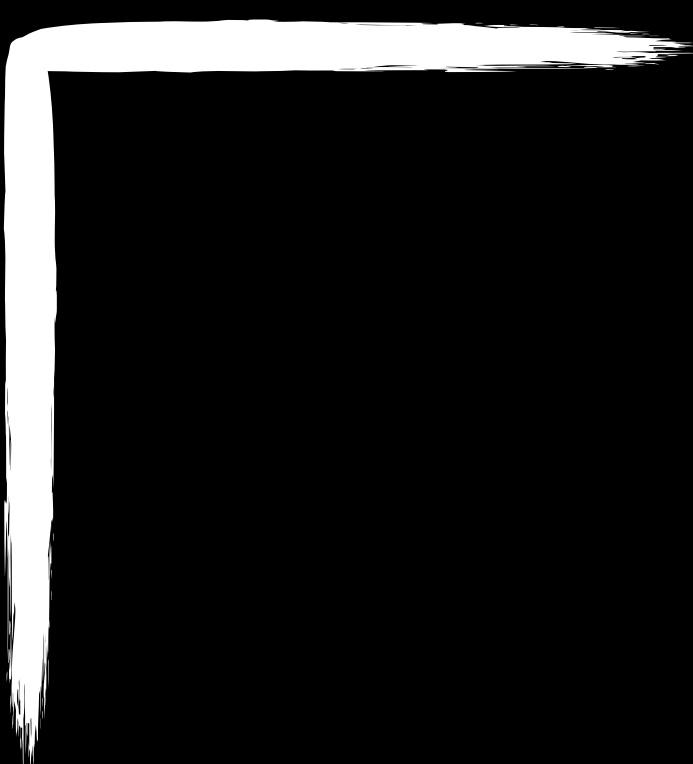
(Moon mass: 7.342×10^{19} tons)

But while the gold counterfactual is false, the plutonium one is true. Why?

One way to see that the statement about **PLUTONIUM** is a law is that an explanation of why it is true requires us to appeal to several other laws but no initial or boundary conditions, meanwhile that's the case for the statement about **gold**.

In any case, we promote our assessment (not explanation) of LoN from simply being a **universal truth** to also include **counterfactual support**.





Questions?

Group

Make yo

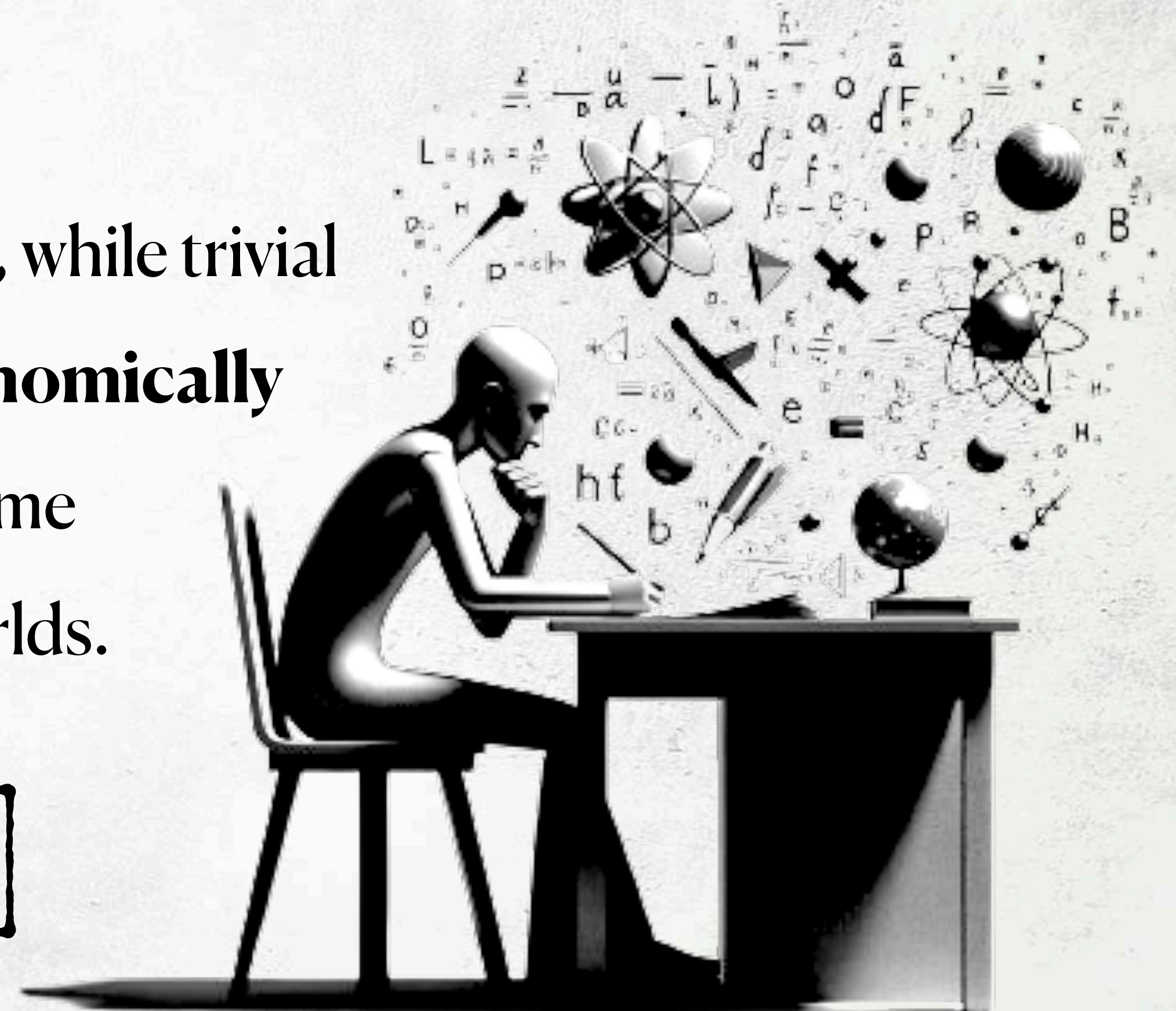


We still haven't answered what this *necessity* is:

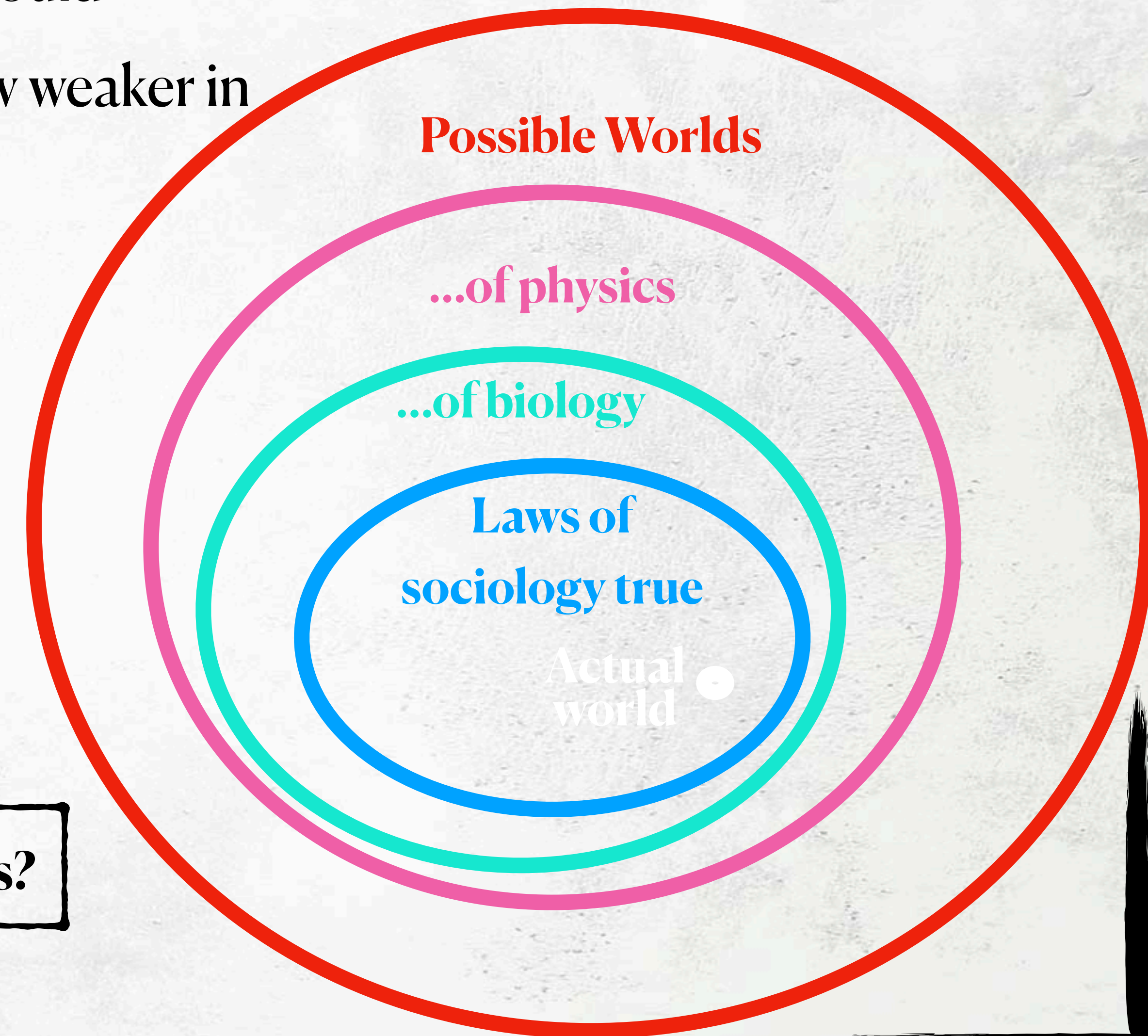
For instance, it's easy to conceive a world where the law of gravitation decays with the third power, but seems to be impossible to imagine a world where the even numbers are not multiples of 2.

It seems impossible to conceive of logical violations, while trivial to conceive of natural laws violations. So we talk about **nomic** necessity instead logical necessity: truths are true in some restricted (but still expansive) collection of possible worlds.

Q: Laws of nature are logically necessary. Thoughts?



We could imagine a hierarchy of necessity: logical (all worlds), physical, chemical, biological, etc such that natural laws' necessity would be conditioned to one of these levels, which grow weaker in terms of violation impossibility. Perhaps a useful notion, it still does not provide an explanation for the necessity of laws, but just ground that necessity into the different layers of the natural world.



Q: Can we conceive of an airplane flying backwards?

Case Study: Philosophical Zombies



Philosophical zombies are hypothetical beings that are indistinguishable from humans in every observable aspect but lack conscious experience, qualia, or sentience.

The conceivability of p-zombies is often used in arguments against physicalism—the view that everything is physical, including consciousness—and to support dualism, the idea that mental phenomena are non-physical.

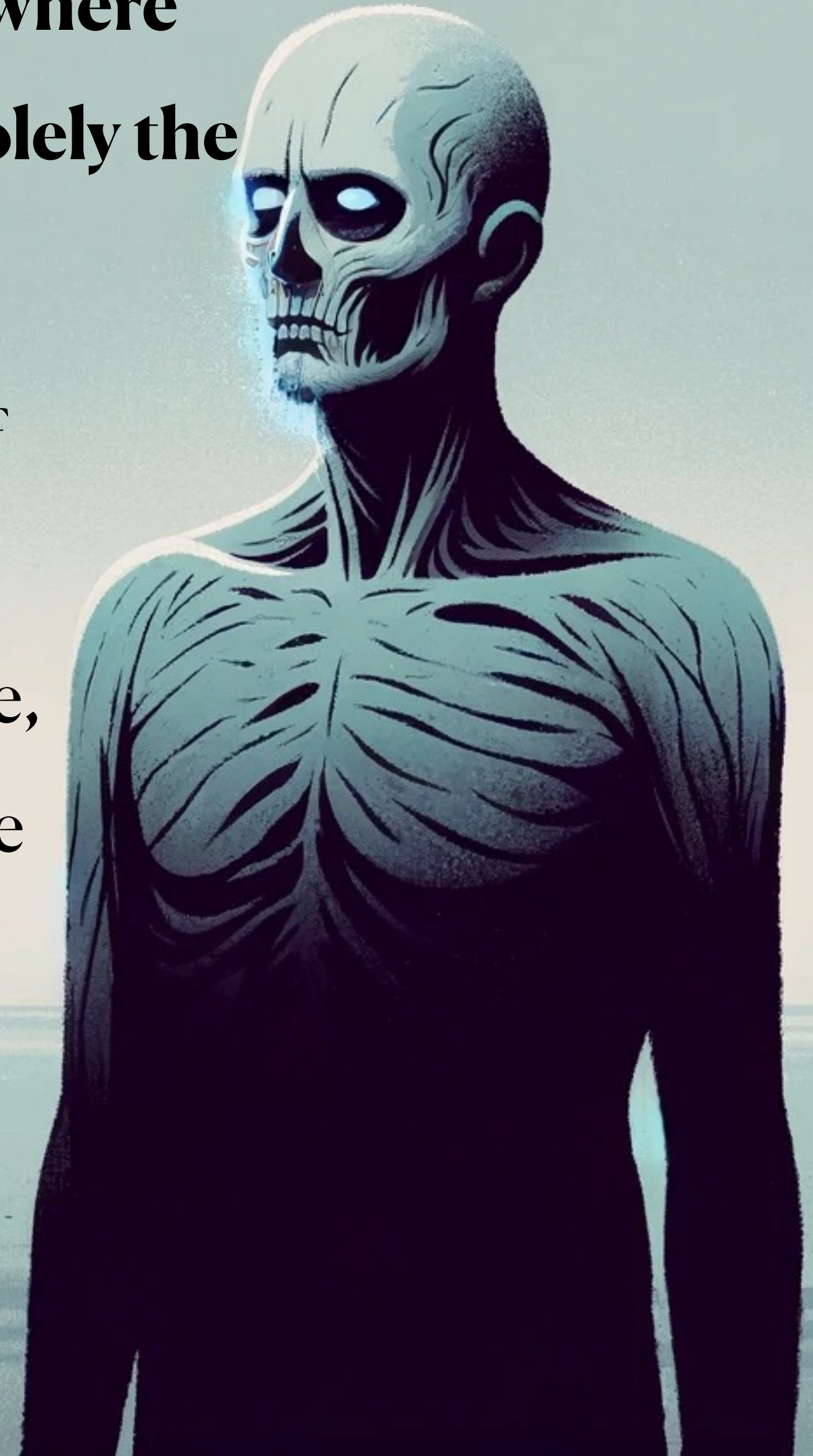


The argument is:

If it is conceivable that a world physically identical to ours could exist where beings have no conscious experience, then consciousness must not be solely the result of physical processes.

This argument uses a counterfactual scenario to challenge the universality of physicalism regarding consciousness. The key point here is the counterfactual support for the claim that consciousness is not physical: if physicalism were true, then a world physically identical to ours but without consciousness could not be conceivable.

Q: What do you think?



However, the use of philosophical zombies and the conceivability argument faces several criticisms:

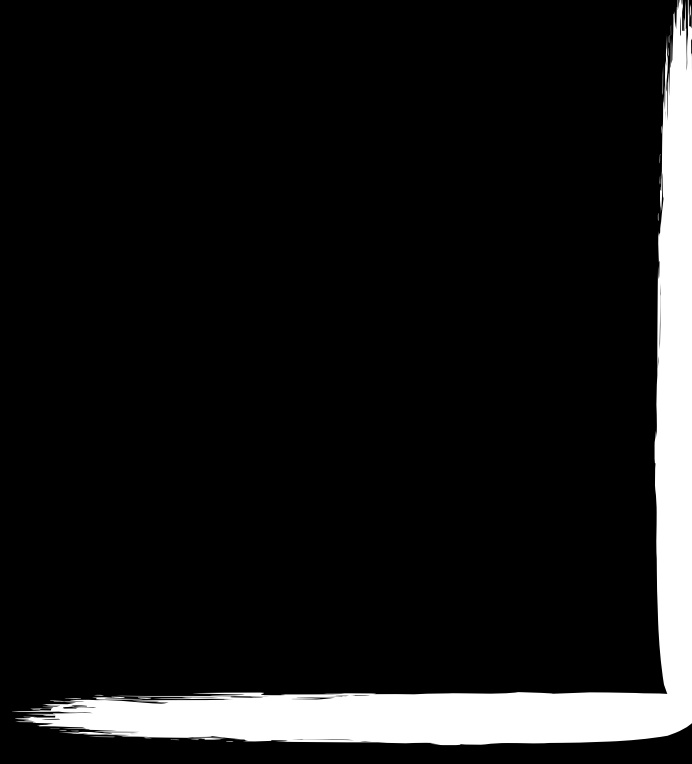
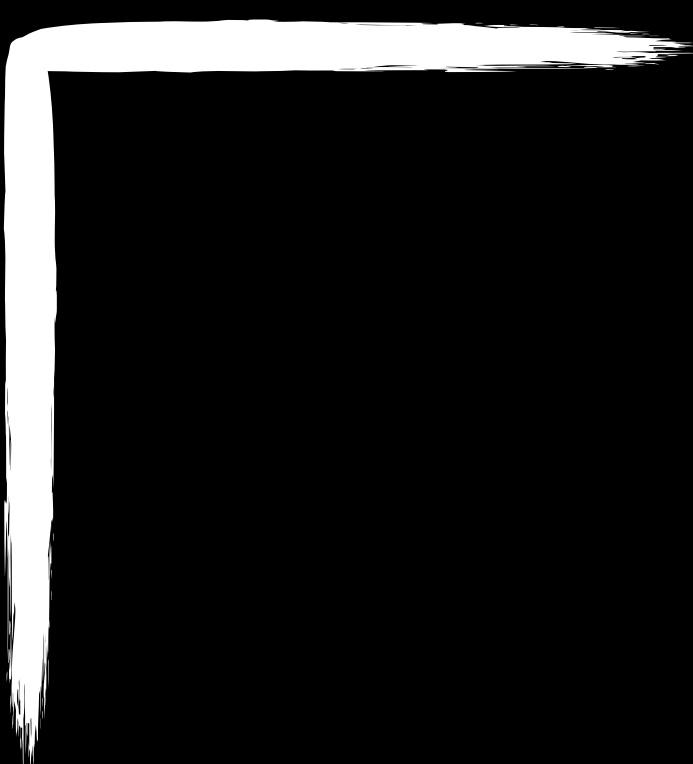
- **Conceivability vs. Possibility:** Just because something is conceivable doesn't necessarily mean it's possible. Critics argue that our ability to conceive of p-zombies may not entail their metaphysical possibility.

Q: Can we conceive of an airplane flying backwards?

- **Question of Conceivability:** Some argue that what we conceive of as a philosophical zombie might still involve some form of consciousness, questioning whether true p-zombies are even conceivable

- **Counterfactual Causation:** The argument assumes that physical and mental states are distinct enough that one could exist without the other. Critics challenge this by questioning the nature of causation and the relationship between physical processes and consciousness.





Questions?

Reading Exercise:

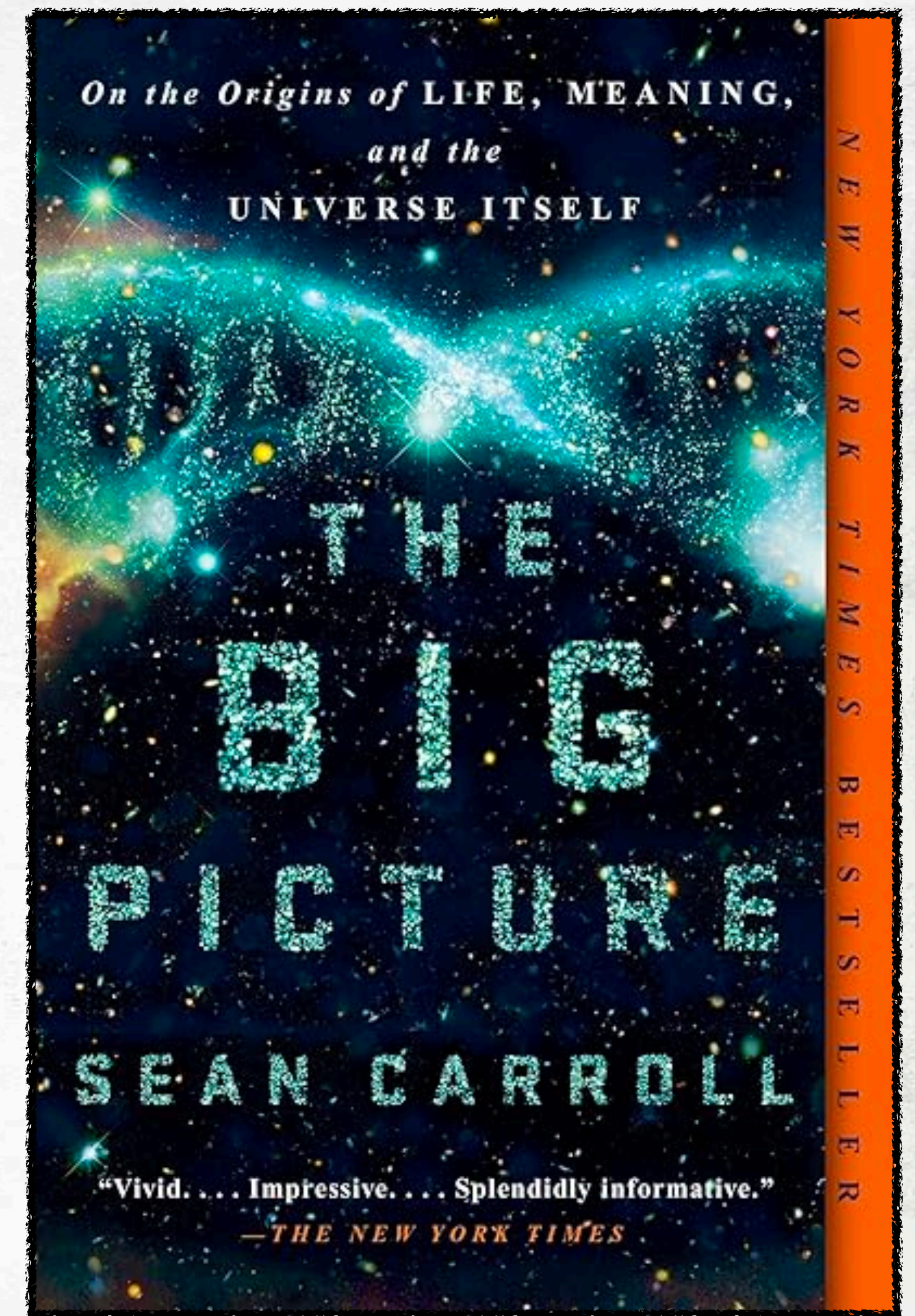
Counterfactuals and Causation

We have seen necessity playing a role before when we discussed the connection between cause and effect in the context of causation. Let's get back to that topic to see whether it can illuminate the necessity of laws. Where is the causation glue that holds together causes and effects?

Reading Exercise: Chapter 3 from the book

"The Big Picture" by Sean Carroll (10 minutes)

Discussion: 5 - 10 minutes



Where are we at?

Laws of Nature seem to be:

- Universal in scope
- Synthetic
- Distinguished from ATG
 - ✦ LoN are in some sense necessary in a way that ATG are not
 - ✦ This necessity is not quite logical necessity (there are possible worlds where the laws do not hold)
 - ✦ But they support counterfactuals in a way that distinguishes them from ATG



In spite of the lack of interest on the metaphysics of laws displayed by the logical positivists, we can keep pushing it.

One attitude is to flip the question and identify necessity with the epistemological attitude implemented by scientists while stating laws .



If it looks like a duck
quacks like a duck
swims like a duck

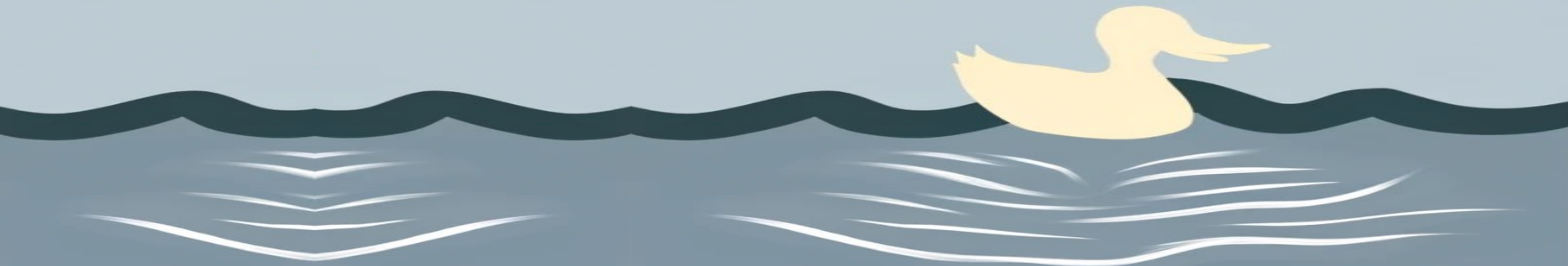
The DUCK Attitude



Then it probably is a duck.

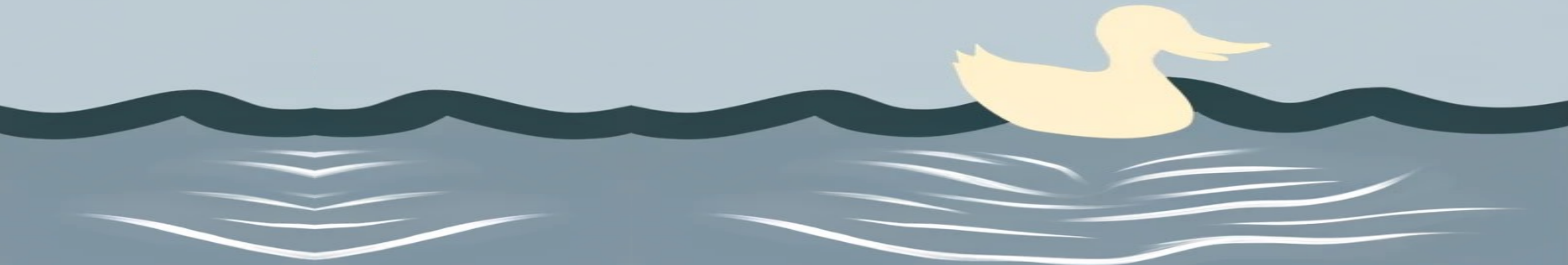
If a given statement is accepted after some experiments, used to ground counterfactuals, satisfy our explanatory curiosity, then it may be counted as a law.

Perhaps, all there is to a law, is to be treated as such. Then, even the fact there is no super massive gold object becomes a law and the fact it has no counterfactual support only highlights an illusion of necessity – an illusion that should be dispelled.



Of course, **the issue is** that our best scientific hypothesis are not laws, and should not be mistaken for them, because they seem to be proven wrong over and over again. Thus, the way we treat them cannot be used to distinguish laws from other regularities.

And so we turn again to the metaphysical realm! Or do we?



Best-System's Account



Many philosophers, sympathetic to empiricism, proposed that the problem of nomic necessity could be solved by avoiding metaphysics: what makes something a LoN requires nothing more than logical necessity and **the existence of a set of statements about reality that exist independent of anyone who might take notice of or believe them.**

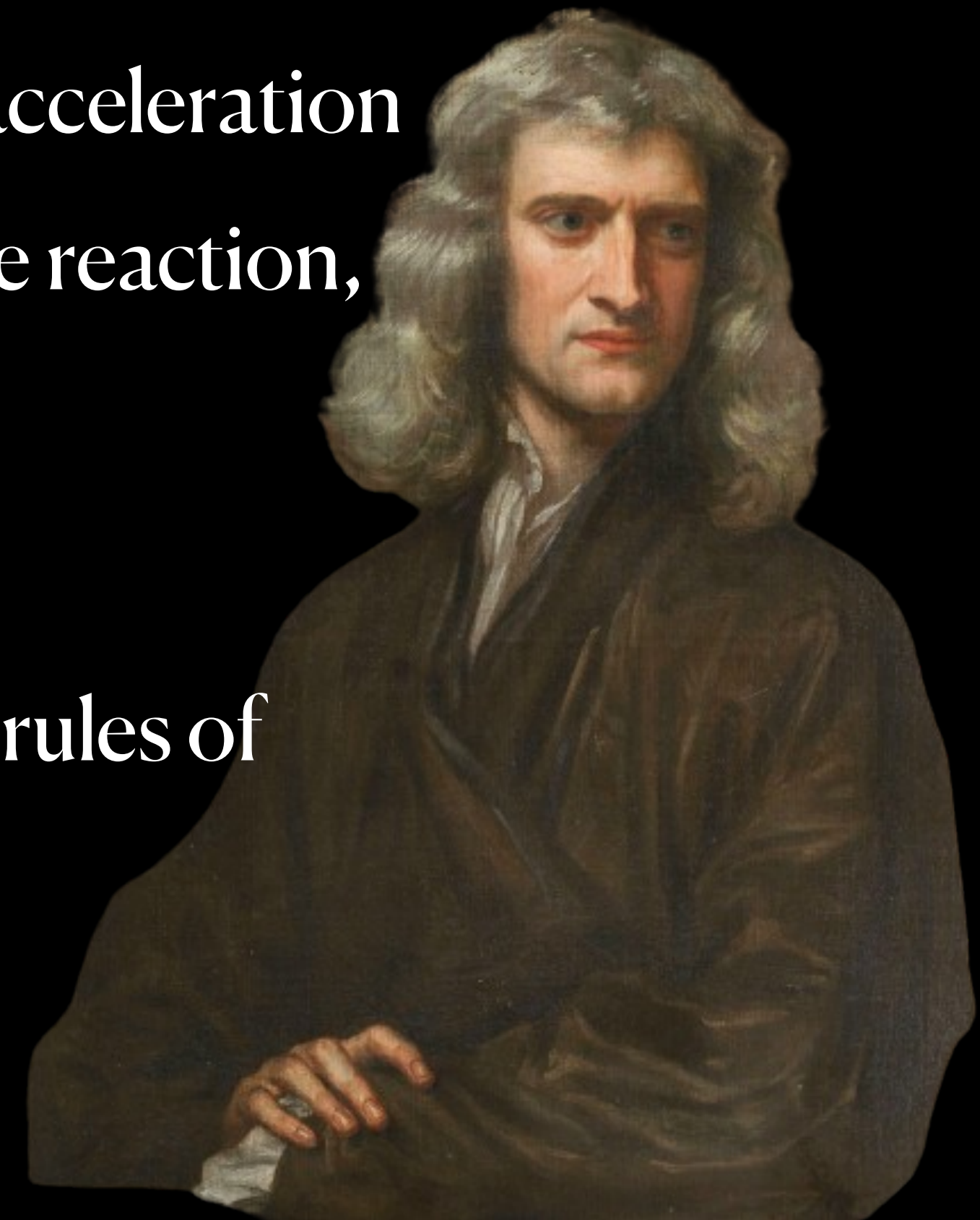
In some corners, this list of statements are called **brute facts about the world** from which many other statements about the world can be derived, similarly to what we saw about the theorem of the internal angles of a triangle summing 180° being implicitly contained inside Euclid's axioms. The question becomes what the set of brute facts is we need to account for all the true statements one can make about the world.

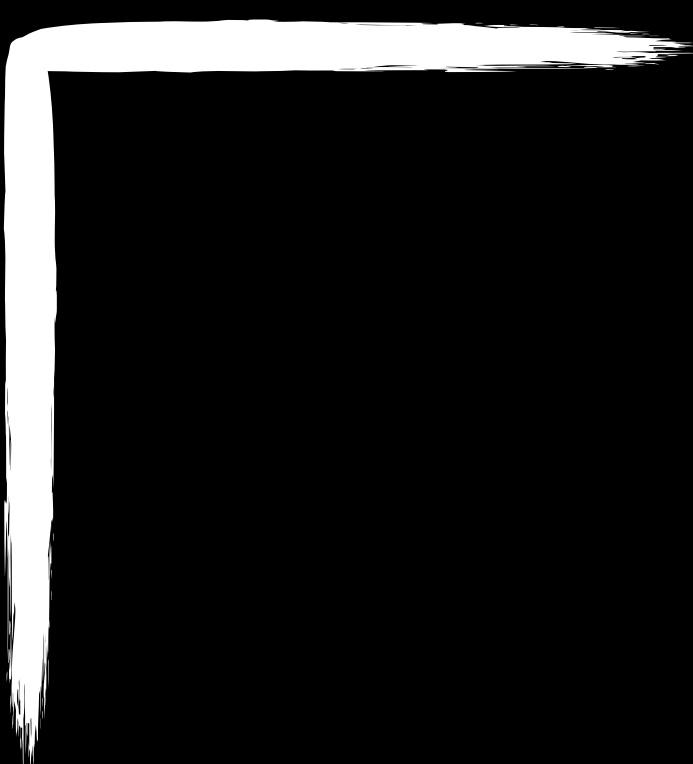


Example: Axiomatic Newtonian Mechanics

1. Any object moving at a constant speed in a straight line continues to do so unless a force is applied to it
2. The force acting on a body is equal to the product of its mass and its acceleration
3. For every action, every application of force, there is always an opposite reaction, a force applied in the opposite direction

From these axioms (plus some 'boundary/initial conditions'), via the rules of mathematics and logic, we can derive any number of truths about mechanical systems.





But what would be the
right book?

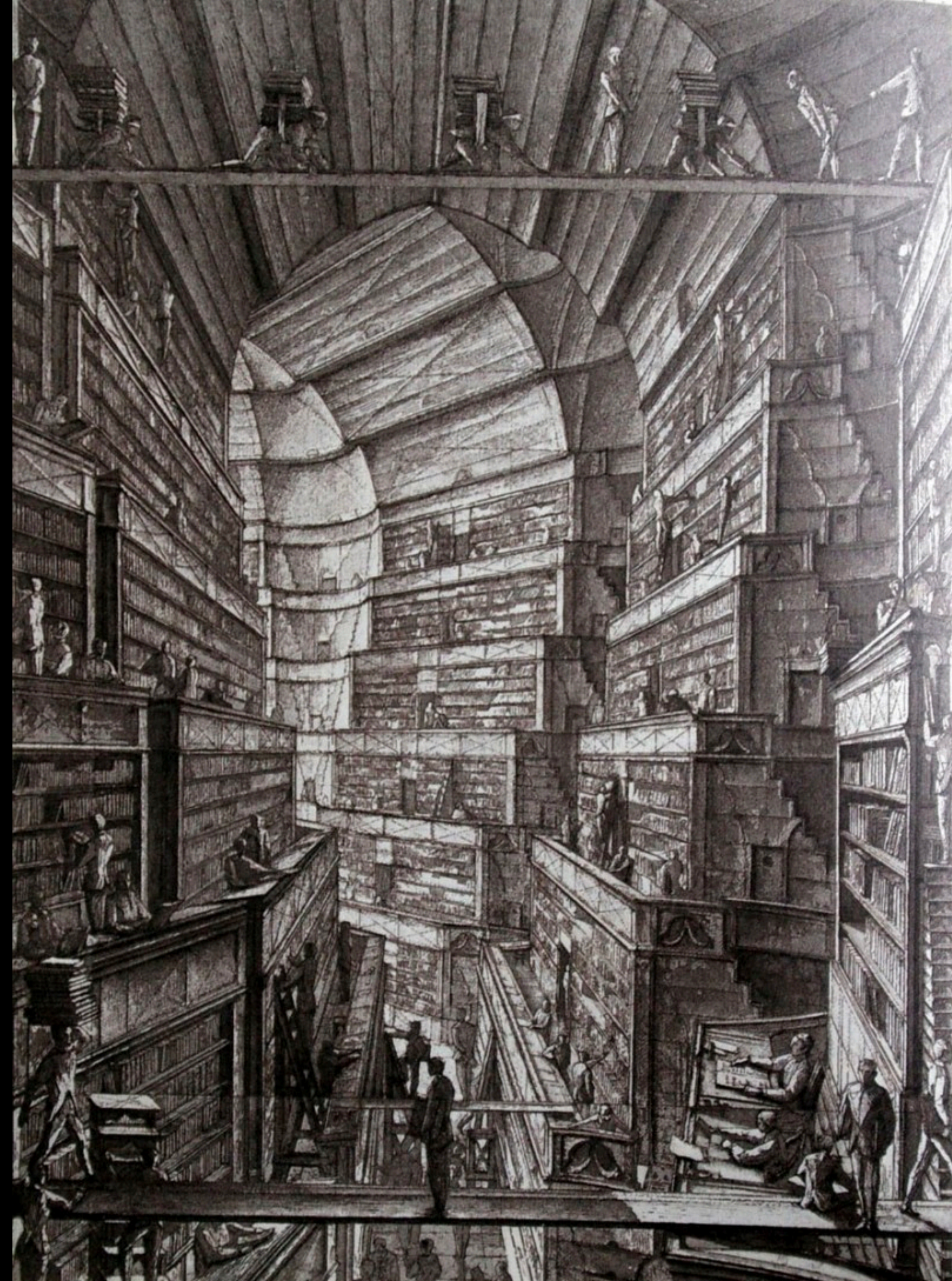


Consider the collection of all true facts about the universe. Call this '**God's Book of Nature**'.

There are several ways of thinking about how to present information in this book, for instance:

- It could simply list one fact after another
- It could list some but not all facts
- There may be ways of summarizing the book, e.g.:
if the facts were $\{Fa, Fb, Fc, Ga, Gb, Gc\}$ this could be summarized with $\{\text{all } Fs \text{ are } Gs, Fa, Fb, Fc\}$.

(The Library of Babel)



Theories (ways of presenting this information) may be measured with respect to:

1. How **strong** they are, e.g. to what extent do they predict all the facts in the Book of Nature, more or less exactly
2. How **simple** they are, e.g. how simple is their axiomatization, how many axioms they include

Q: How simple/strong are the following theories?

1. A list of all the facts, one after another
2. A single axiom: 'something exists'

Simplicity vs. Strength

In general simplicity and strength trade-off against one another:

- One can always **increase the strength of a theory** (unless it is complete), by adding more truths, but this requires adding the truth to the axioms, **which decreases its simplicity**
- One can also **increase the simplicity of a theory** (unless it has no axioms) by removing some of its axioms, but this will in general decrease the number of truths that are derivable, and **so will decrease its strength**



But we may think about the theory which is the **'best balance'** of simplicity and strength.

Q: Which theory is the best balance of simplicity and strength?

1. A list of all the facts, one after another
2. A single axiom: 'something exists'
3. Axiomatic Newtonian mechanics (supplemented information about the initial/boundary conditions)



Best-System's Account

Nomological necessity: a law is a universal statement about the world that is either an axiom or a theorem in all of the deductive systems of propositions that are tied for being the best combination of simplicity and strength in describing all the local matters of particular facts in the history of the universe.

Corollary: A fact is a LoN if and only if it is an axiom in the theory which is the best balance of simplicity and strength

This account:

- Connects laws with “theories of the world” (that explain/deduct everything)
- Relies on logical necessity instead of natural/nomic necessity (propositions and deductions)
- Is metaphysically minimalist: don't invoke any empirically undetectable glue holding together lawfully connected events, but absent from accidental regularities



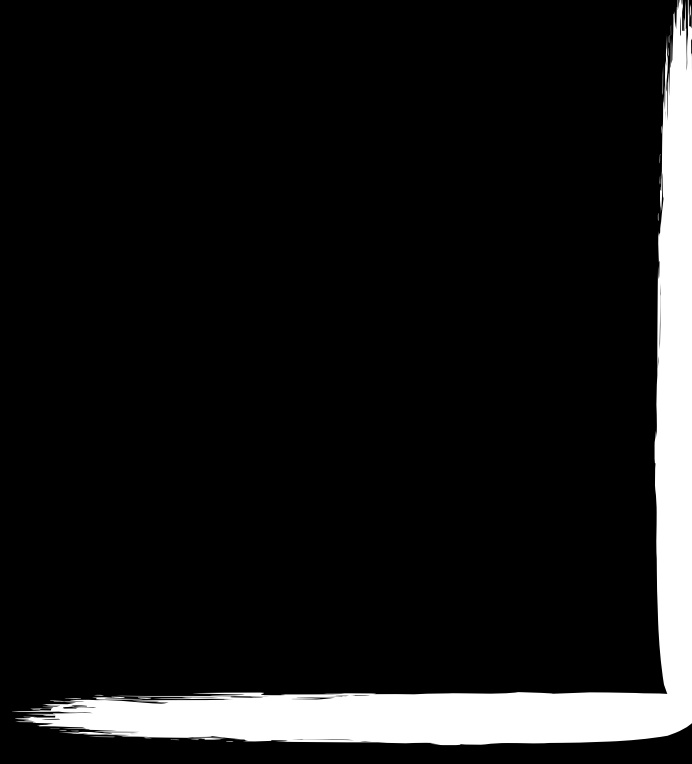
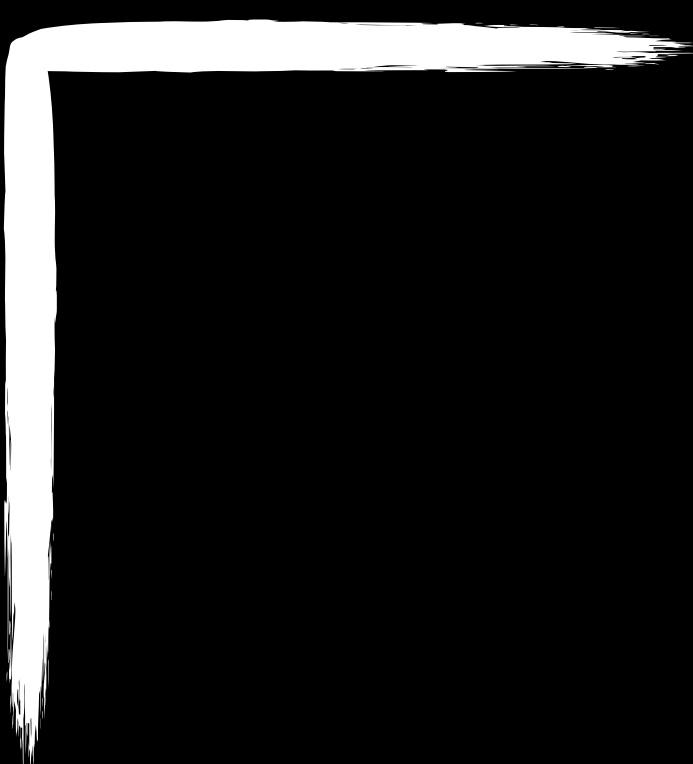
But it is **not sufficiently “mind-independent”**: it does not provide the identity of physical necessity in some metaphysical facts “in the objects,” in the local matters of particular facts, or in any other facts about the world independent of our beliefs about it, rather

- A. Strength: number of truths, but **do some truths matter more than others?**
- B. Simplicity: number of axioms, but what about a single long conjunction?

What if neither of these notions have an objective standard? Those are vague terms that people will disagree on. Are we willing to allow such vagueness in defining an important category such as the one referring to LoN? Even more worrying, **what if it turns out that several systems of axioms are tied for optimal simplicity and strength, but they have no or few propositions in common as axioms and theorems?**

Are we to say that there are no laws of nature or only a few laws?”





Questions?

Plato's Realism and Necessity



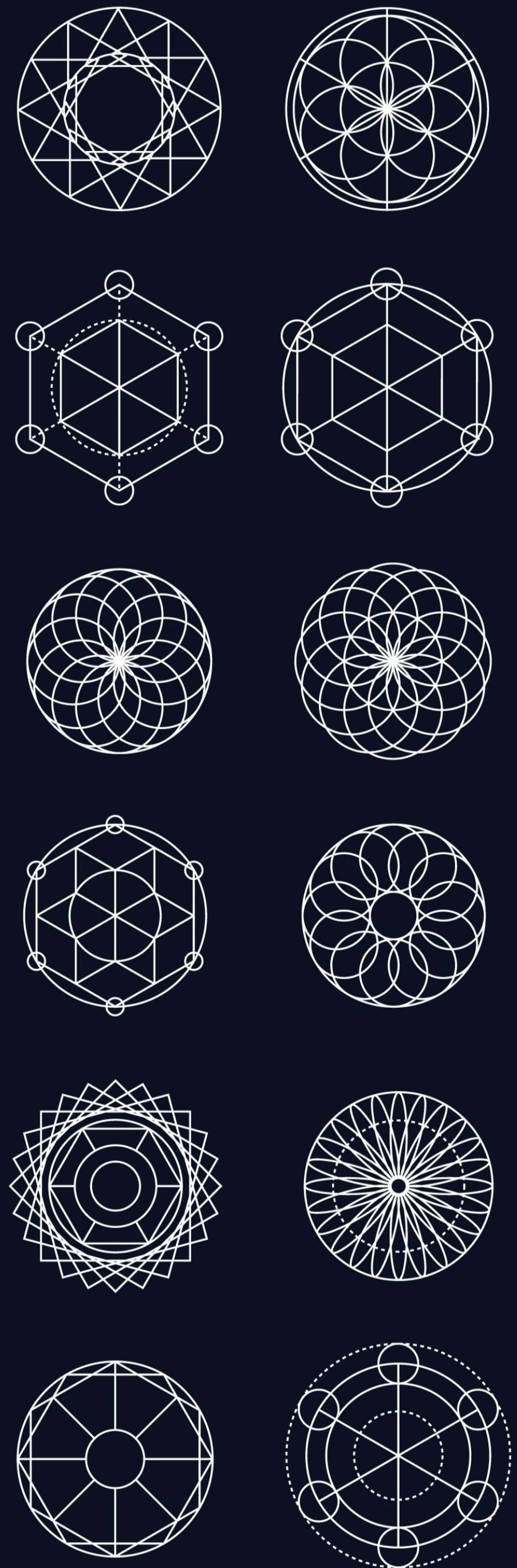
What if laws are not about things in the world, but about properties instead?

Going back to Plato, intrinsic difference between things being red, and the property of **redness**.

(Platonic) Realism is the idea that these properties, called **universals**, do exist independently of the things that instantiate them. This also applies to the concepts of numbers and propositions: we can count till 4 by counting things, but the concept of 4 was there all along, even if there were not things to be counted.

Needless to say, most empiricists reject this thesis!

Q: Where in the universe is the property redness or goldness?

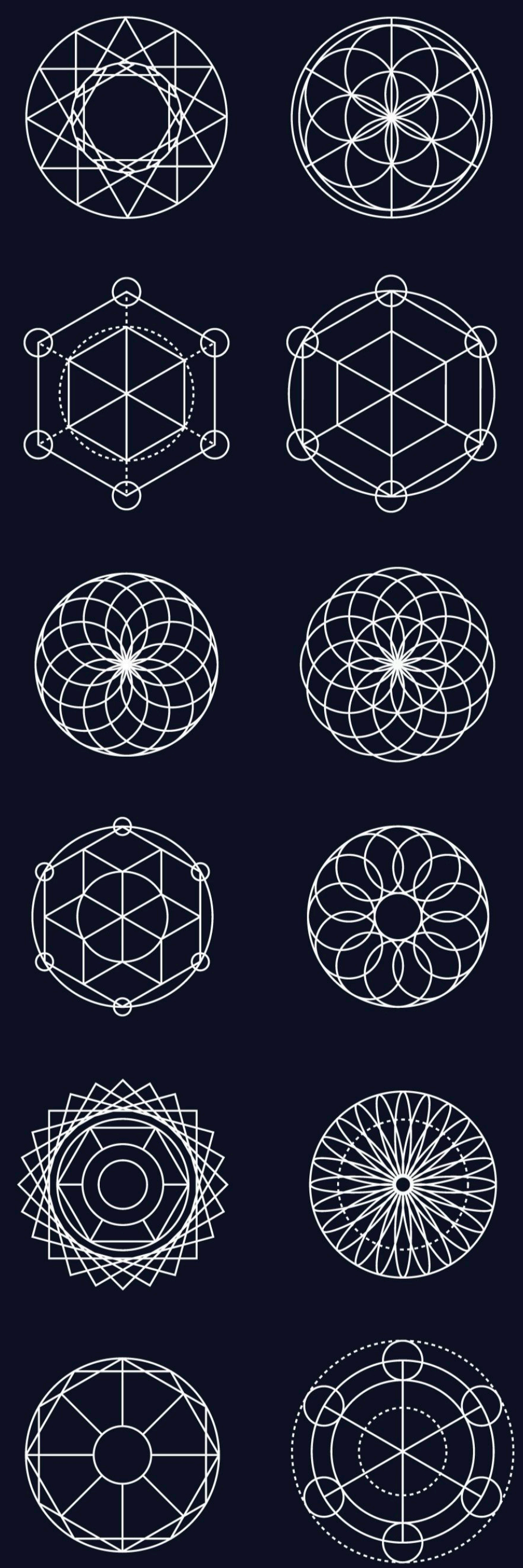


The connection between realism about universals and nomic necessity lies in the explanation of laws as relations between universals rather than merely descriptions of repeated instances or events. When a law of nature is understood as describing a relationship between universals, it asserts that there is a necessary connection between these universals that grounds the law.

Example: "Masses attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them."

This law describes a **relationship** between the universals of "**having mass**" and "**attracting each other**." It's not merely that every instance of a mass attracts every other instance observed; rather, the law suggests a deeper, abstract relationship between these universals themselves.

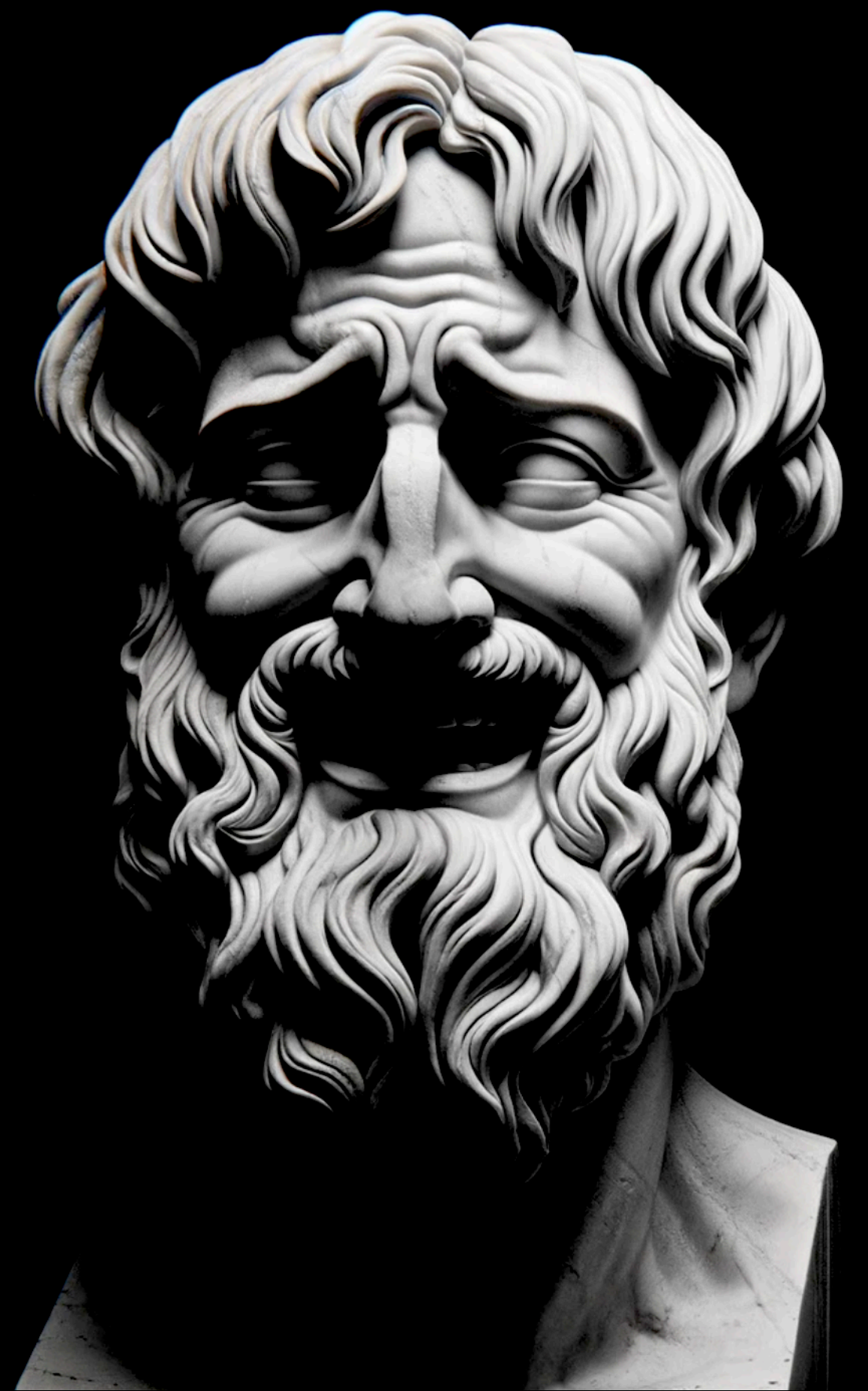
The necessity comes from the intrinsic relation between the universals.



Some **positive** aspects of this view are:

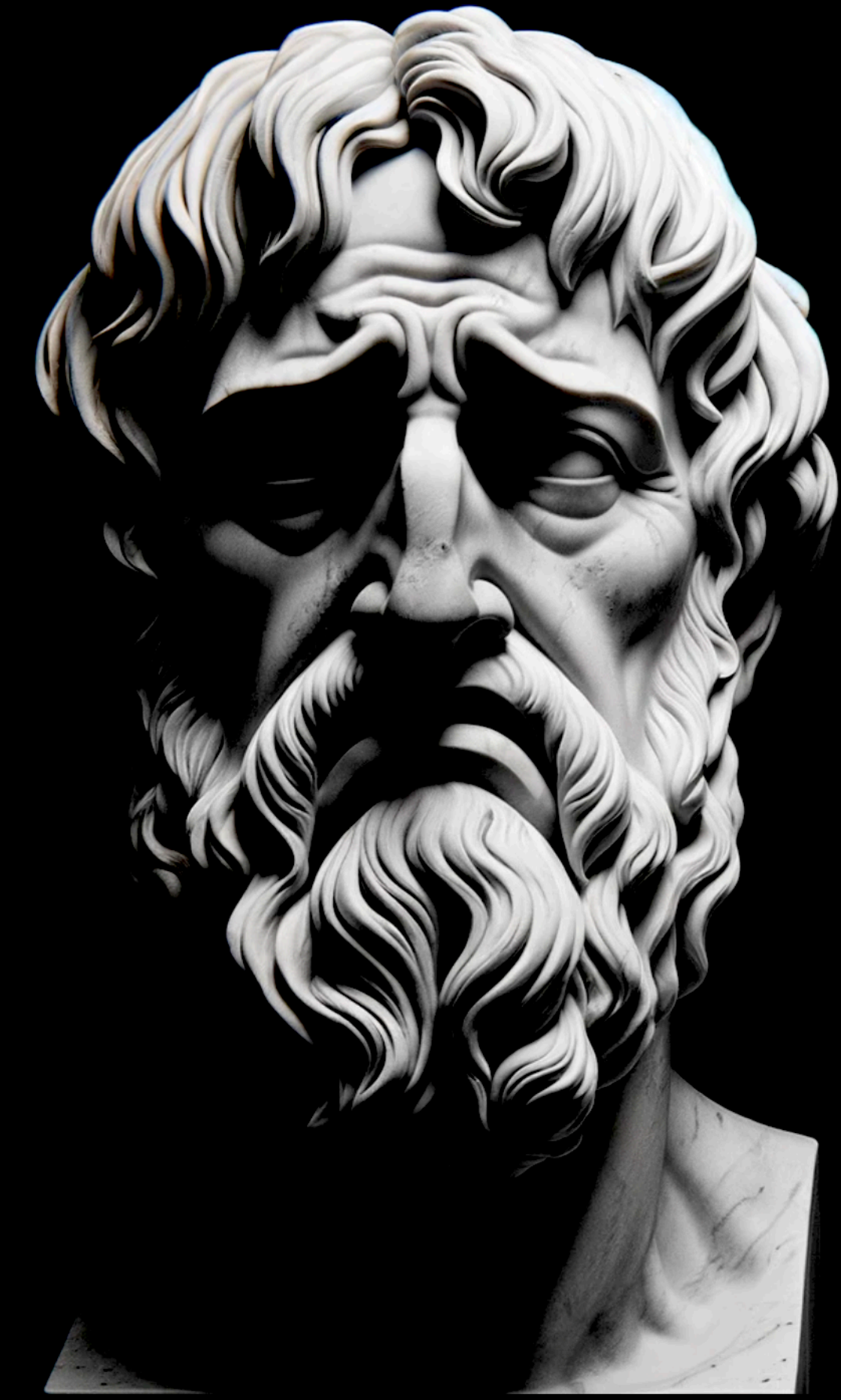
- It **does not contain any “glue”** among things since necessity is uplifted to universals
- Another advantage of realism is that **universals**, like numbers and propositions, if they exist at all, **exist quite independent of the thoughts of any cognitive agents**. So this approach avoids the problems of the best- systems theory
- It **fits with why we cannot ‘observe’** whether something is a law, we cannot observe universals

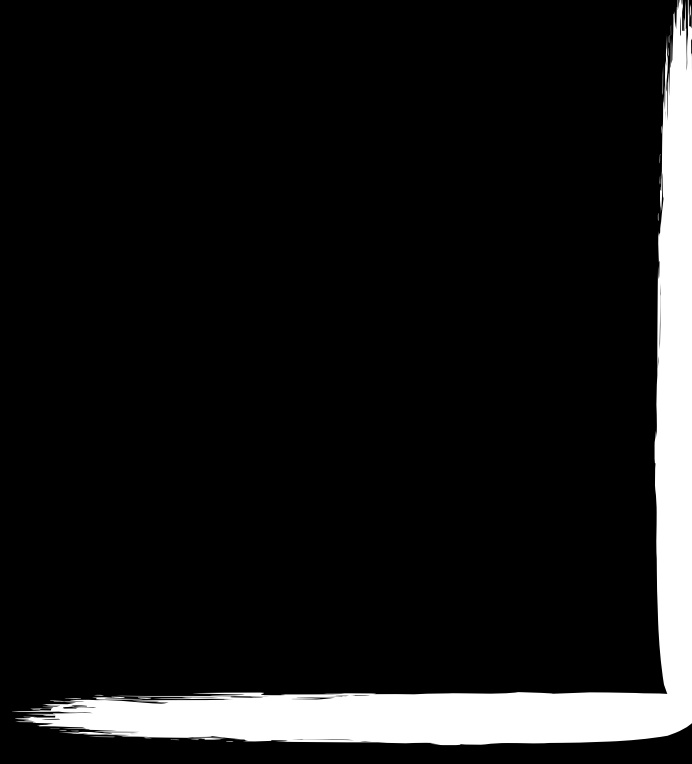
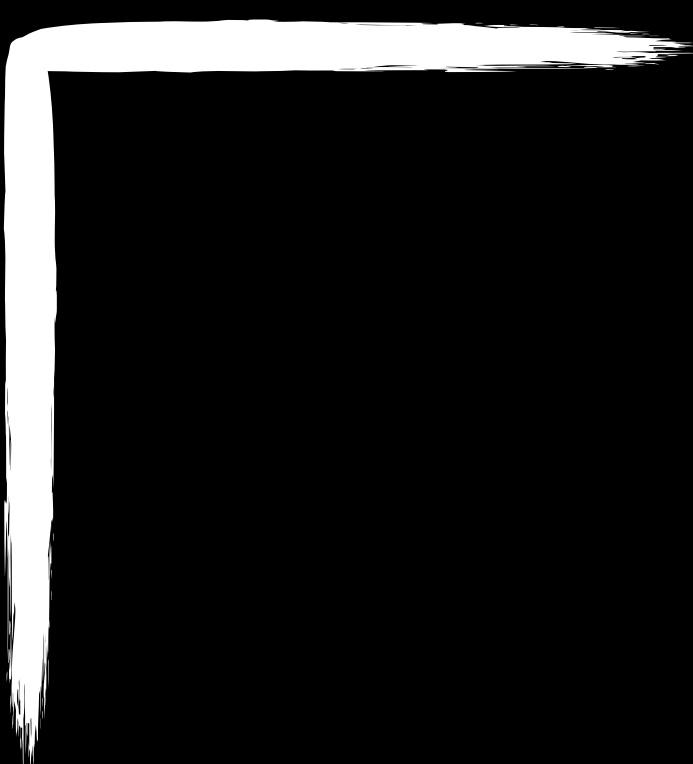
Q: Is this satisfying?



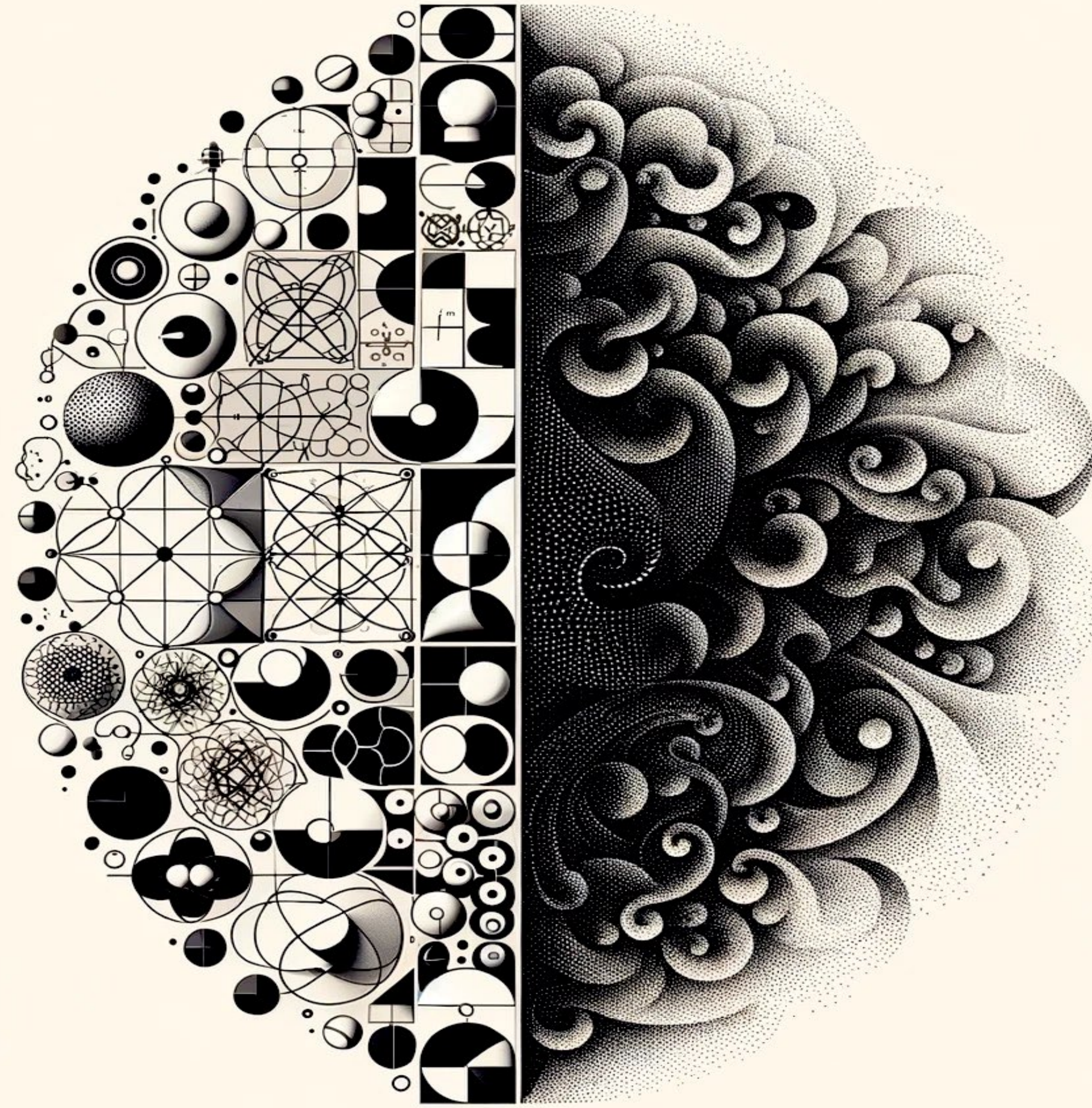
Some **negatives** aspects:

- The **hard problem of universals**: how “redness” have anything to do with being red?! A universal is by definition completely removed from the physical world, so how would it latch on it?
- By attributing nomic necessity to the relations between universals, we're moving the question of necessity from the observable phenomena (the instances) to the abstract realm (the universals). But then: **Why do these universals exhibit necessary relations?**





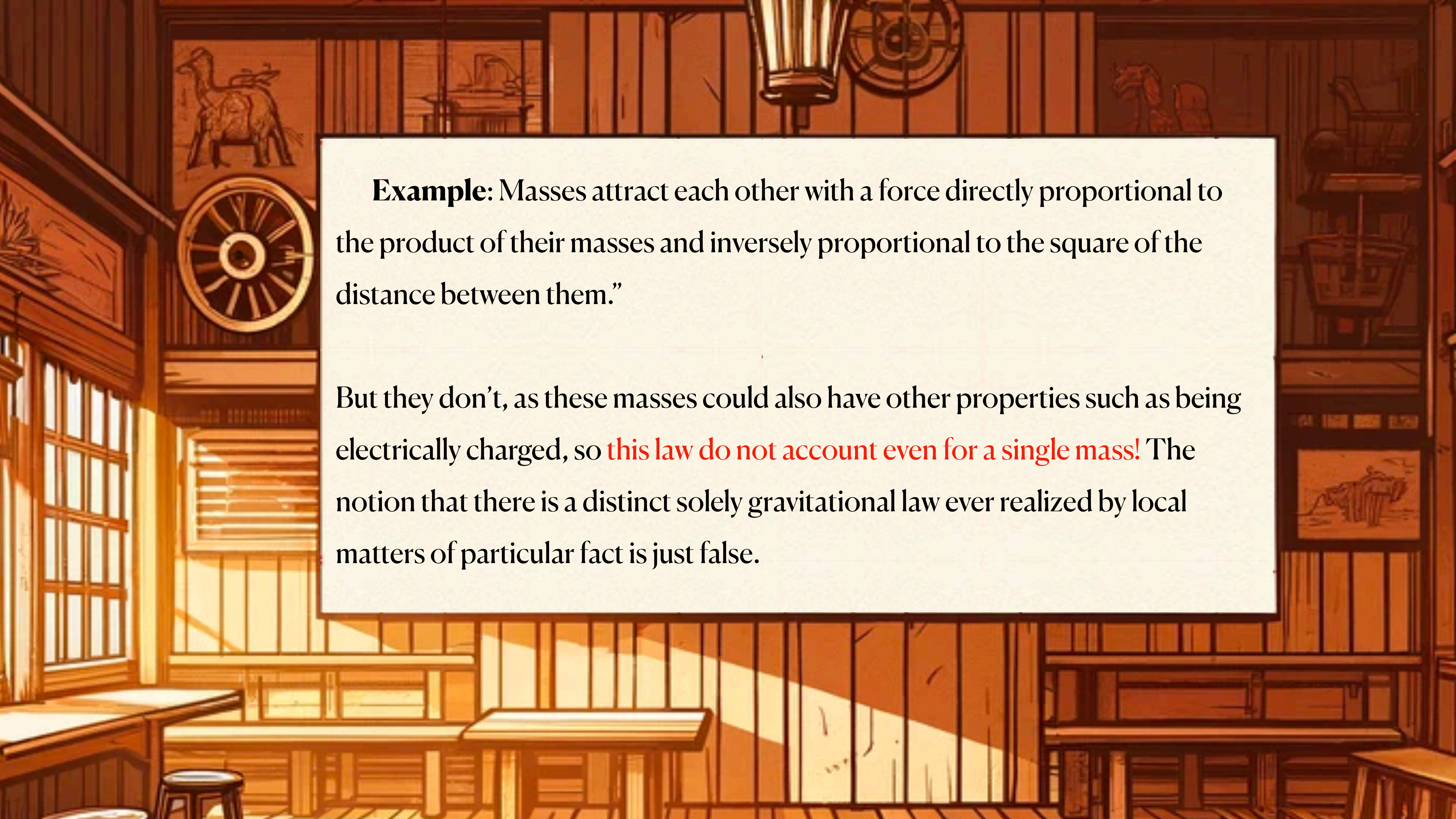
Questions?



**How do we know there are laws of
nature?**

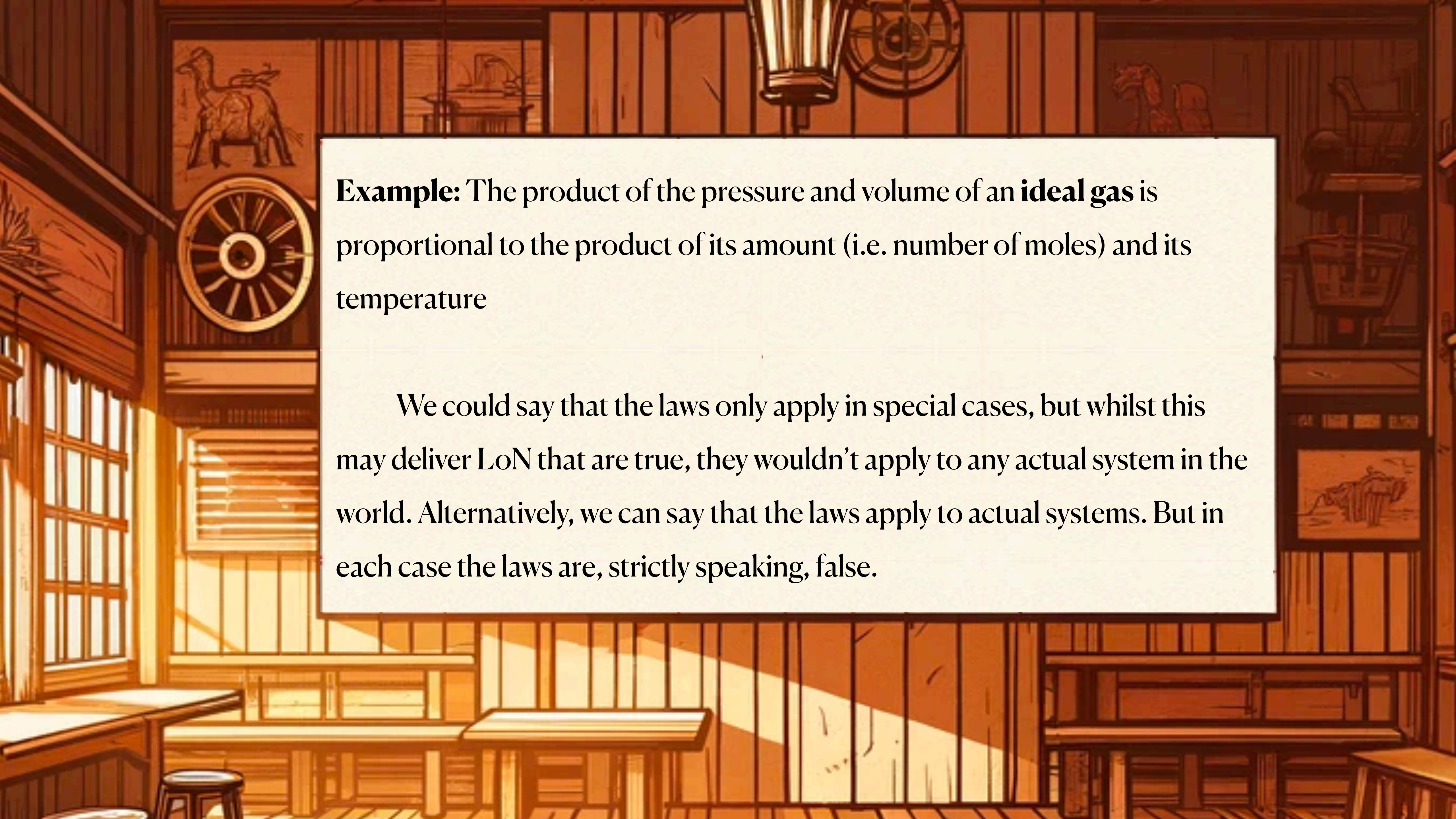
NO LAWS ATTITUDE





Example: Masses attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them.”

But they don't, as these masses could also have other properties such as being electrically charged, so **this law do not account even for a single mass!** The notion that there is a distinct solely gravitational law ever realized by local matters of particular fact is just false.



Example: The product of the pressure and volume of an **ideal gas** is proportional to the product of its amount (i.e. number of moles) and its temperature

We could say that the laws only apply in special cases, but whilst this may deliver LoN that are true, they wouldn't apply to any actual system in the world. Alternatively, we can say that the laws apply to actual systems. But in each case the laws are, strictly speaking, false.



Cartwright proposes denying that scientific explanations invoke exceptionless universal regularities that obtain in nature. That in fact, our claimed laws are typically “obtained in vacuum”, “spherical cows”, and do not hold in reality:



Q: Thoughts on this?

Cartwright insists that what scientists do, their analyses and dissection of the world into components, which lead to these abstract laws, do not correspond to the innerworkings of nature – nature is a whole!

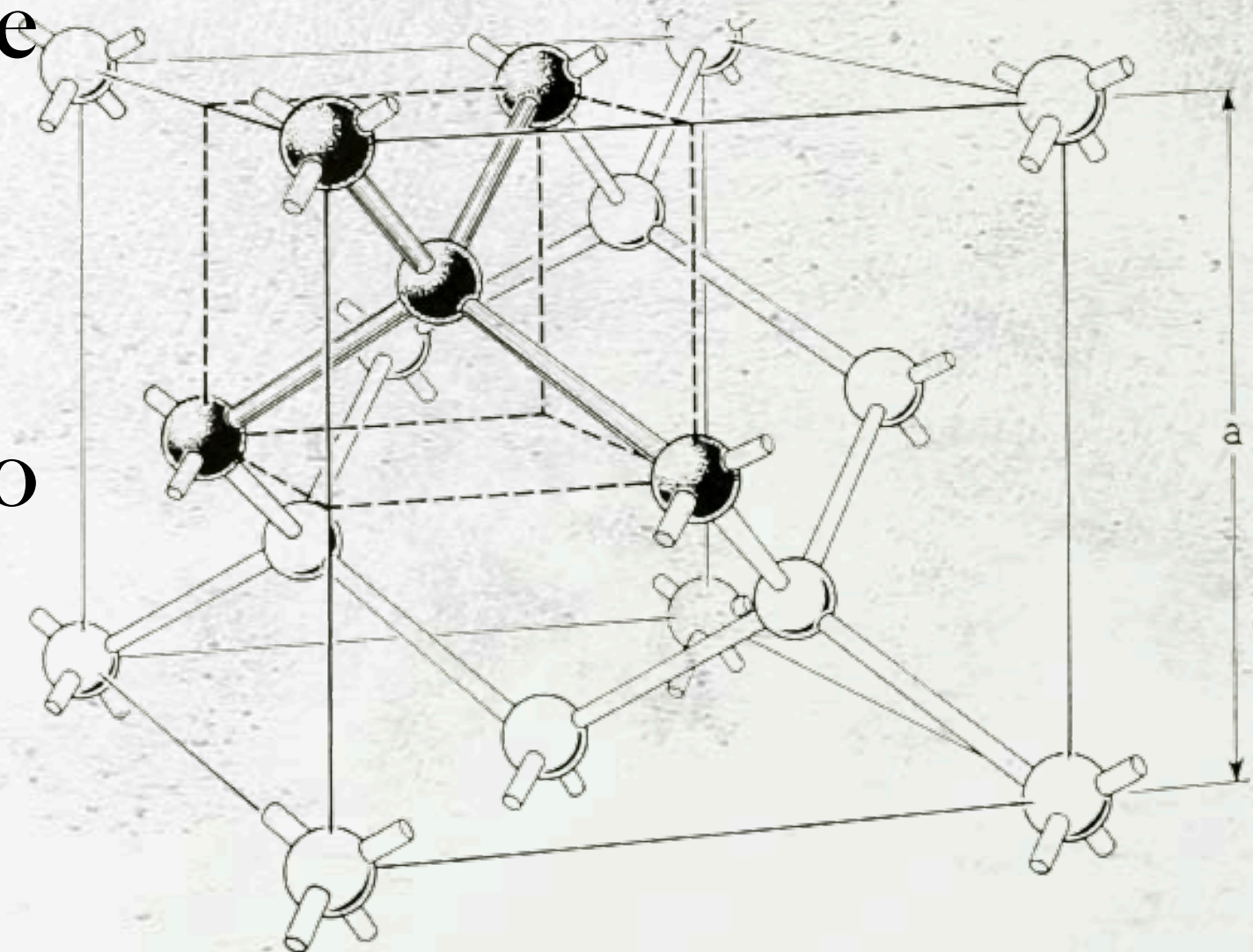
It's all about
DISPOSITIONS!

The idea is that LoN describe dispositions of objects in the world,
i.e. tendencies they have to act in such and such a way:

- A glass has the disposition to break when dropped
- Two bodies have the disposition to attract one another with such an such a force

Notice that that an object can have the disposition to do something, even if it never in fact does that.

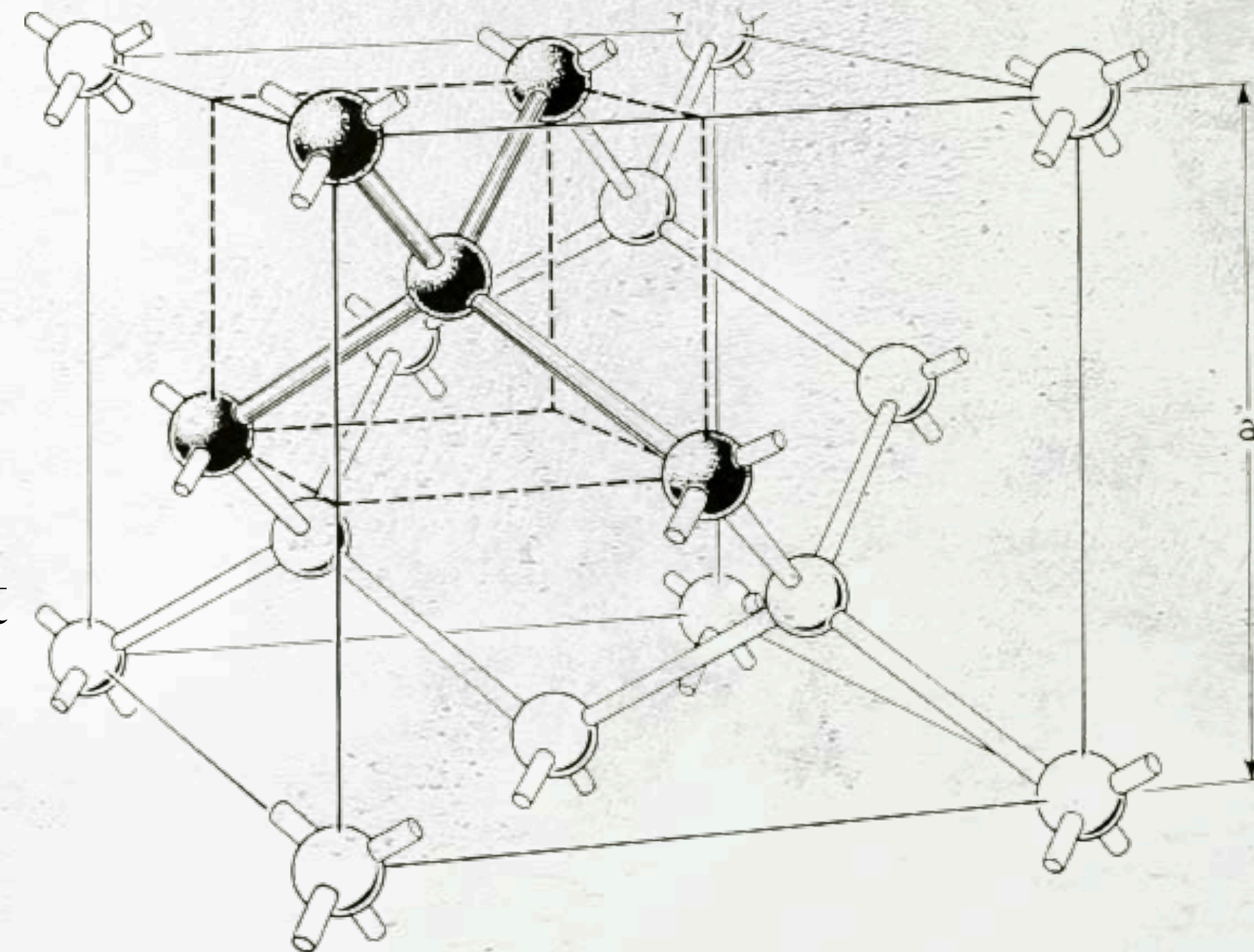
(Nancy Cartwright)



Cartwright suggests that it's the dispositions that are important, these are what makes our laws of nature useful for predicting and explaining the world, but we should recognize that:

- Any law describes a single (or small collection) of dispositions, and this simplicity is what makes them seem explanatory, but
- The world is full of complex phenomena (lots of dispositions interacting in complex ways), in a way that means that no single law describes them truthfully

Response: what are these dispositions!? Does it help, when asking how opium puts people to sleep, to be told that 'opium has the disposition, a dormitive virtue, to put people to sleep?'. Maybe we need to know the underlying details of the disposition for this to be helpful, but this amounts to knowing the laws of the constituents of opium!



Essay 1

Deadline February 25th at midnight!

2. Prompt

Choose **one** of the following three topics:

- (1) Scientific Explanation
- (2) Laws of Nature
- (3) Causation

For the chosen topic, write an assignment that completes the following tasks:

- (a) Explain one philosophical view on this topic in full. In doing so, explain a benefit or argument in support of this view
- (b) Describe an example (invented, from the course literature, or drawn from some external courses) and demonstrate how the philosophical view manages to account for the example
- (c) Explain at least one objection to the view under consideration.

3. Grading

The essay will be graded on a scale from 1-5. You must score at least 1 out of 5 on each assignment to pass the course.

- a) 1-2 points for presenting a view
- b) 1-2 points for describing an example that fits with the view
- c) 1 point for presenting an objection to the view and explaining why it is a problem for the view.

The differentiation within each of these will be determined by the clarity of the explanation and the quality of the essay as a piece of philosophical writing. Quality will be judged primarily based on structure.

Next Time (Feb 16th) - Causation and the Special Sciences

To read (all on Athena):

- Rosenberg (& McIntyre) – Chapter 5
- Mitchell – “Dimensions of Scientific Law”

Optional:

- SEP - Regularity and Inferential Theories of Causation