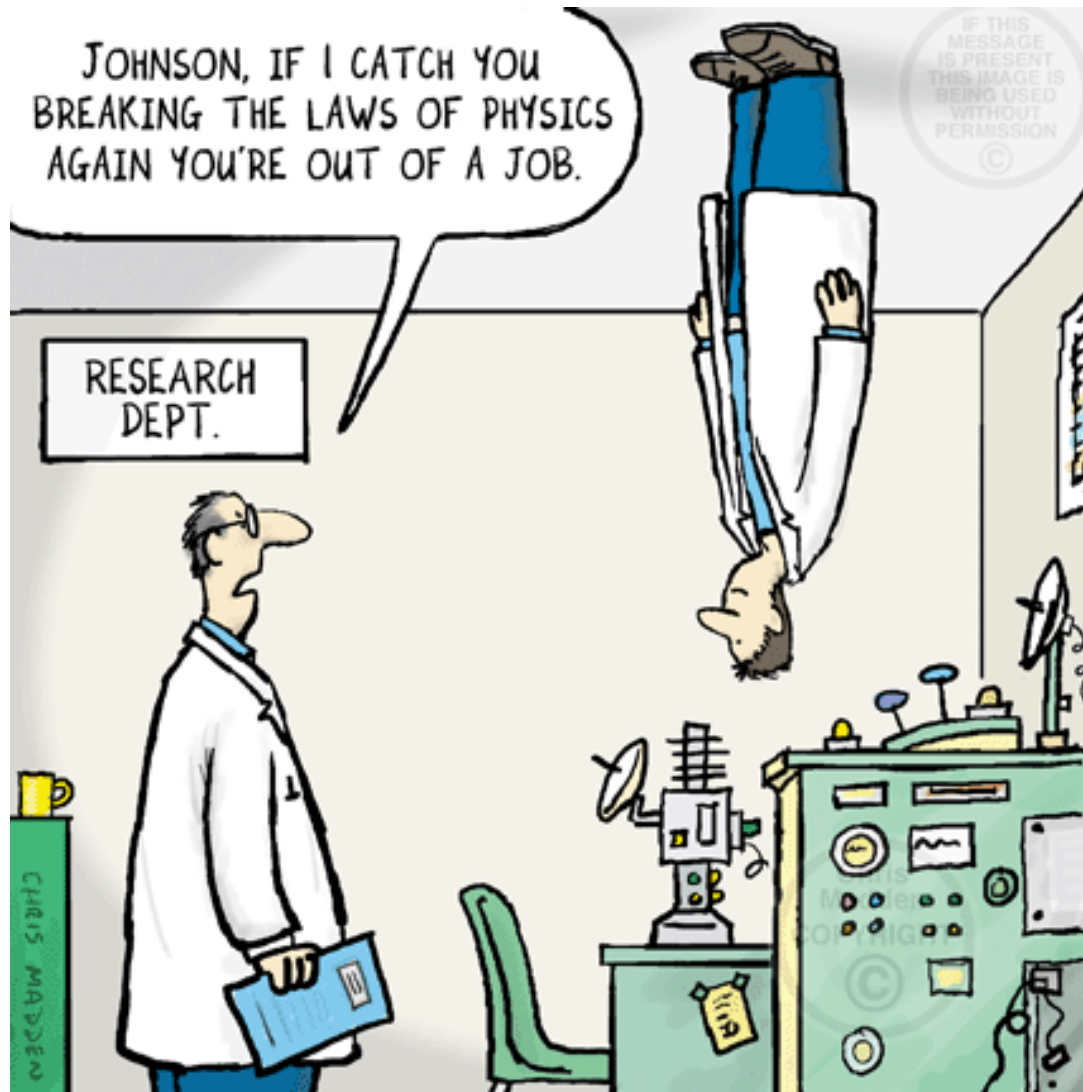




Laws of Nature

What the heck are they?



Do physical laws *govern* the world?

- We often answer ‘why’ questions by appealing to laws of nature.
- E.g. Why do planets move along ellipses? Because the law of gravity is an ‘inverse square’ law. (Mathematically, that gives you an elliptical orbit.)
- So, do laws *cause* things to happen? (Are they “pushy”?)

- The relation between *causes* and *laws* is rather tricky (and interesting!) Many questions are raised, such as:
 1. Do laws *cause* things to happen?
 2. What *are* laws, anyway?
 3. Do laws require a lawgiver?
 4. Why does matter obey these particular laws?
 5. (Why does matter obey laws at all?)
 6. What about stochastic processes? Do they obey laws as well?

Laws vs. ‘accidental generalisations’

- What *is* a law of nature? At the very least, it seems to be a true generalisation.
- A generalisation is a proposition of the form “All F are G”, e.g. “All metals expand when heated”, “All ravens are black”, etc.
- A true generalisation has no exceptions, or counter-instances, such as pink ravens.
- Can you think of a law that is not a true generalisation?

Laws vs. ‘accidental generalisations’

- So all laws are true generalisations. But are all true generalisations laws?

Apparently not. Consider the generalisation:

“All dogs ever born at sea have been and will be cocker spaniels.”

Even if this were true (and it could conceivably be true) it would be merely *accidental*, due to some cultural preference of sailors for a particular breed of dog.

- In a similar way, the following true generalisations seem to be merely accidental:

“All spheres of pure gold are less than 1 mile in diameter”

“Everyone in this room has less than \$10,000 in cash in their pockets”

- What extra ingredient is needed to make something a law?

- Laws seem to have an added ingredient of *necessity*, i.e. they *must* be true. It's not an accident, or a matter of luck. Something "forces" them to be true.
- Laws of nature aren't logically necessary, since we can imagine them being false. So instead we say they're 'nomically' necessary.
- This idea of 'nomic necessity' is somewhat mysterious, and so many philosophers reject it. (Notably David Hume.) Such philosophers propose a *regularity theory* of laws.

Laws are explanatory

- In science, laws are often used to explain why certain things happen (or don't happen).
- E.g. Newton's laws explain why the planets all orbit the sun along an ellipse, and why the tides follow the moon.
- Can accidental generalisations *explain* anything?

What is necessity?

- The easiest kind of necessity to understand is *logical necessity*, which is defined in terms of logical consequence.
- $P \Rightarrow Q$, i.e. Q is a logical consequence of P, just in case it is rational to infer Q, with certainty, from P.
- Then Q is logically necessary just in case Q is a logical consequence of the empty set $\{\}$, i.e. Q can be inferred from no premises at all.

Examples of logical necessity

- “Either the universe had a beginning or it did not.”
- “All fish are fish”
- $2+2=4$
- If Fred is late, then he isn't on time.

- Are laws of nature *logically* necessary?
- No. They cannot be figured out just by thought, or by “pure logic”. They could, conceivably, be different from how they are.
- They have a weaker kind of necessity, called ‘nomic’ or physical necessity.
- E.g. “Cows do not jump over the moon” is physically necessary, but not logically necessary. In order to infer that a cow doesn’t jump over the moon, you need to assume some general facts about the world.

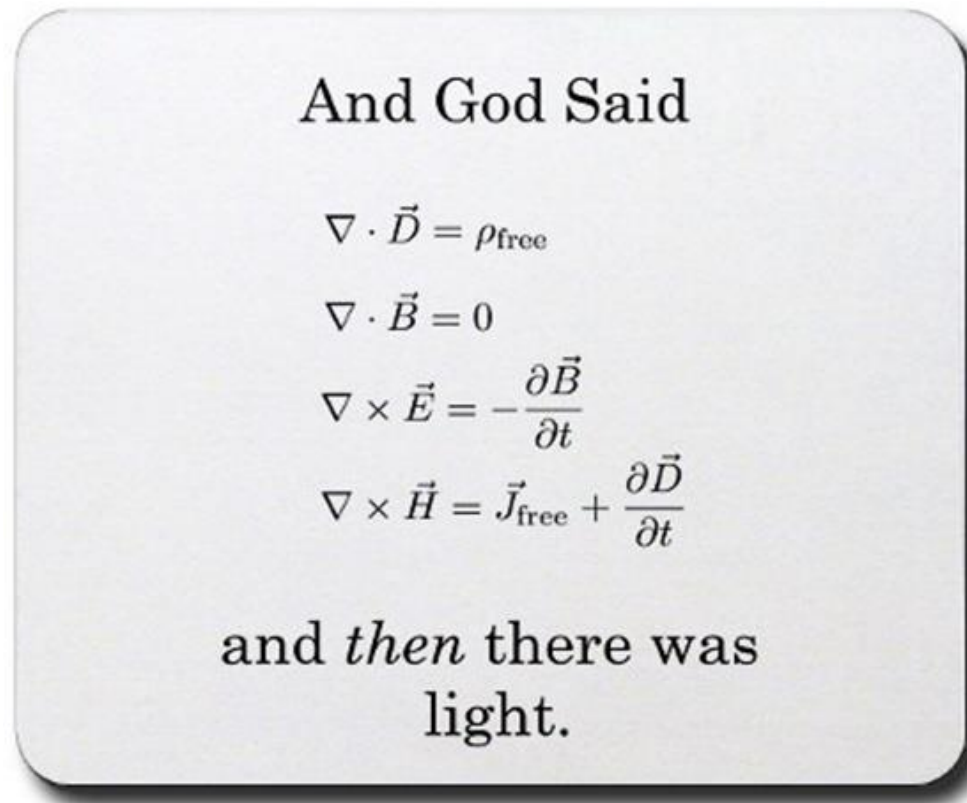


- E.g. Minecraft has its own “laws of physics”, that differ from the usual ones.

Views about nomic necessity/laws

1. Primitivism (e.g. David Armstrong)
 - Nomic necessity is a basic, or “primitive”, relation that cannot be usefully analysed in terms of anything else.
2. Regularity (e.g. David Lewis)
 - “All F are G” is a law if it is a simple regularity. (More precisely, if it is a theorem of all simple-yet-powerful axiomatic theories of physics.)
3. Inferentialism (e.g. Brian Ellis)
 - “All F are G” is nomically necessary just in case it is a *logical consequence* of some basic and unchanging fact about the world, such as the essence or nature of matter.

4. Laws are divine commands?



This view, called *voluntarism*, was proposed in the Middle Ages. But how would it work?

Laws are divine commands?

- How would inanimate matter obey Divine commands?
Atoms cannot read!
- Some theists say that the laws of physics describe “God’s usual way of acting”. This sounds rather like occasionalism.
- Occasionalism is the (reckoned to be silly) view that created objects have no causal powers of their own.
 - They *seem* to have causal powers, but this is an illusion. Actually God is moving them around, in accordance with the laws of physics.

Inferentialism

- In cases where $P \Rightarrow Q$, we often say that Q is necessary *given* P , or just “ Q is necessary *for* P ”.
- E.g. It’s raining \Rightarrow the ground is wet.
- We can say that the ground is *necessarily* wet, *given* that it’s raining.
- According to inferentialism, laws are necessary *given* the natures of the objects concerned.

E.g.: “Positive and negative charges attract”

- Primitivism
 - This fact is nomically necessary, which entails that it always occurs. (We cannot say what nomic necessity is.)
- Regularity
 - It is simply a fact that opposite charges move toward each other, unless impeded. There is no necessity to it.
- Inferentialism
 - The essence (or nature) of charge logically entails that opposite charges are attracted to each other. (We can't say what the essence of charge is, however.)

1. Do laws *cause* things to happen?

- If laws can explain, then it seems that they must be “pushy”, i.e. cause things to happen.
- On the inferentialist view, that laws are consequences of the nature of the system, it’s actually those natures/essences that do the causing. E.g. the nature of a body causes it to move in a straight line.
- What about the other theories?

4. Why does matter obey these particular laws?

- A hard question.
- How can each view of nomic necessity answer this question?

4. Why does matter obey these particular laws?

- Some cosmologists speculate that the laws of physics vary across the total universe (or “multiverse”). Our laws hold merely in a certain region (“our universe”).
- Interestingly, cosmologists who play with different model universes, having different physical laws, find that life could not exist in such universes. Our laws are apparently “finely tuned” for life.
- Can we just say: “The reason we have *these* laws is that, if the laws were different, then we would not be here to talk about it”?

5. (Why does matter obey laws at all?)

Here's the answer we have:

6. What about stochastic processes?

- There are stochastic (or probabilistic) laws, having the general form: If F then $\text{Prob}(G) = q$

E.g. If this coin is flipped then the chance of heads is 0.50031.

In other words, the law assigns a chance to each possible outcome of an experiment.

Such laws are tricky to understand. In particular, *what is it for a system to “obey” such a law?* Any finite behaviour is consistent with any chance! (E.g. a fair coin *can* land heads 100 times in a row.)

- Which views about physical laws can account for the existence of stochastic laws?