Laws of Nature

What makes a universal claim a law?

- There appears to be a difference between two kinds of claims investigated by the sciences. Some of them appear to be lawlike—they are serious candidates for being laws of nature; while others don’t appear to be lawlike—they are not serious candidates for being laws of nature.
  - For instance:
    * All electrons are negatively charged.
    * All U.S. presidents are male.
- Here’s a first-pass shot at the difference: the claim that ‘all electrons are negatively charged’ is unrestricted—it doesn’t make reference to any particulars. Whereas the claim that ‘all U.S. presidents are male’ is restricted—it does make reference to the particular country of the United States.
  - Problem: there are universal, unrestricted claims which are not lawlike. For instance, ‘all presidents of countries which declared independence in 1776 are male.’ This doesn’t make reference to any particular country, and it is true, but it still isn’t a law.
  - Another problem: consider the following pair of claims:
    * There are no gold spheres with a diameter of over one mile.
    * There are no uranium spheres with a diameter of over one mile.

The first claim is true, but not a law of nature. The second claim is also true, but it is a law of nature, since the critical mass of uranium makes it impossible for there to be any sphere of uranium with a diameter of over 1 mile.

What are the properties of a law of nature?

- In general, philosophers of science have supposed that a law of nature
  - is of the logical form $(\forall x)(Fx \to Gx)$
    * All gases have temperatures $T$ which are a function $c \cdot P \cdot V$ of their pressures and volumes; all massive objects exert a gravitational force upon one another directly proportional to the product of their masses and inversely proportional to the square of the distance between them.
  - supports counterfactual conditionals
counterfactual conditionals are claims about what would have been the case, had things been different—e.g., ‘If I had dropped the glass, it would have shattered’.

- receives (projective) confirmation from its instances
  * observing a coin flip land heads does not (projectively) confirm the generalization “All flips of this coin land heads”; however, observing a negatively charged electron does (projectively) confirm the generalization “All electrons are negatively charged.”
- figure into correct explanations.
  * The law of gravitation explains why unsupported objects near the earth’s surface fall. However, the true generalization “All U.S. presidents are male” does not explain why Barack Obama is male.

Two Philosophical Theories of Laws of Nature

- We’re going to consider two different philosophical accounts of what it is that makes a true universal generalization a law of nature.
- According to the first theory, a law of nature is a certain special kind of regularity. What makes it a law that ‘all Fs are Gs’ is, in part, just the fact that all Fs actually are Gs.
- The best-developed version of the regularity account of laws comes from John Stuart Mill, Frank Ramsey, and David Lewis. It is called the ‘best systems account of laws.’
  - On the Best Systems account, the laws are the theorems of the deductive, axiomatic system that strikes the best balance between simplicity and strength.
    * A system is simple just in case it involves fewer axioms. It is stronger just in case it entails more truths. These virtues compete. The system consisting of the one axiom which says that Barack Obama is the 44th president of the U.S. is very simple, but it is not very strong at all. The system consisting of an axiom for every single truth is very strong but not very simple.
    * Mill, Ramsey, and Lewis believe that the axiomatic system which strikes the best balance between simplicity and strength will entail that there are no uranium spheres over a mile in diameter, but will not entail that there are no gold spheres over a mile in diameter.
- According to the second theory, what makes it the case that it is a law that all Fs are G is that there is a special kind of relation—the necessitation relation—holding between the property of F-ness and the property of G-ness.
  - This theory is developed and defended by Fred Dretske, Michael Tooley, and David Armstrong.
  - So, it is a law that (∀x)(Fx → Gx) just in case N(F, G).
  - This theory says that, since N(electron-ness, negative charged-ness), it is a law that all electrons are negatively charged. However, since it is not the case that N(U.S. president-ness, male-ness), it is not a law that all U.S. presidents are male.
• Because properties like $F$-ness and $G$-ness are called ‘universals,’ we can call this ‘the Universals Account.’

**Humean Supervenience**

• One respect in which these accounts differ is that one of them entails a thesis known as *humean supervenience*, while the other does not.

• In general, the claim that $X$ supervenes upon $Y$ is the claim that it is impossible for $X$ to be any different without $Y$ being any different. Equivalently: it is the claim that there are no two possibilities which are alike with respect to $Y$, but different with respect to $X$. Fixing $Y$ fixes $X$.
  
  – The claim that the mental supervenes upon the physical is just the claim that it is impossible for somebody’s mental state to be any different without their physical state being somehow different. Equivalently: there are not two possibilities which are alike with respect to their physical properties which are not also alike with respect to their mental properties. Fixing the physical properties fixes the mental properties.

• *Humean Supervenience* is the thesis that every fact supervenes upon the distribution of physical properties throughout spacetime—from the universe’s inception at the big bang through its entire history. Fixing the entire history of the physical universe fixes all the facts that there are. Once God has determined all the facts about local, physical quantities, God has determined all the facts that there are. God doesn’t have to additionally determine what the laws of nature are, or what the chance laws are, or what the causal relations are, or what object’s dispositions are.

• The Best Systems account is consistent with *Humean supervenience*. The Universals account, however, is inconsistent with *Humean supervenience*.
  
  – According to the Best Systems account, once you fix the facts about the physical world throughout its history, you have thereby fixed the facts about which claims are theorems of the deductive system which strikes the best balance between simplicity and strength. So you have thereby fixed the facts about the laws as well.
  
  – According to the Universals account, however, it is possible that two possible worlds agree about all the physical facts throughout the universe’s history, but disagree about what the laws are.

• Tooley uses this fact to argue against the Best Systems account.
  
  – Tooley: it is possible that there be a world with 10 different types of fundamental particles. Then, there will be 55 possible two particle collisions. Suppose that the laws govern what happens when any two particles collide. It is possible that even though 54 of these collisions occur in the entire history of the universe, the 55th (between particles of type $X$ and $Y$) never occurs. Call a world like this a ‘54 collision world.’
P1 It is possible that a 54 collision world have a law saying that, when \( X \) and \( Y \) collide, they annihilate each other.

P2 It is possible that a 54 collision world have a law saying that, when \( X \) and \( Y \) collide, they emit a particle of type \( W \) and type \( Z \).

C1 The laws of the 54 collision world are not determined by the physical facts at that world.

C2 Humean supervenience is false.