connections and processes
                - this pushes science to describe something beyond the observable phenomena
        - in fact the language of explanation is similar to that of description
            - but whereas description is a relation between theory and fact, explanation is a relation between theory, fact and *context*
- Scientific explanation is not pure science, but an application of science
    - the application depends on context
    - explanation is nothing beyond description - it is simply application
        - success of explanation is the success of adequate and informative description

David Lewis - The Metalinguistic Theory: Laws of Nature

- Laws of nature are often understood such that if an antecedent of a counterfactual is taken together with some laws, and the antecedent is consistent with all laws, then the counterfactual is true. On this view there is no true counterfactual that says if x state of affairs were to hold, then law y would be violated.
- This view of laws *could* be incorporated into Lewis' metaphysics by claiming that there exist possible world 'spheres' around world i such that those worlds do not violate the laws prevailing in world i, and that worlds are more distant insofar as more (qualitatively or quantitatively?) laws of i are violated in them.
- Lewis doesn't so incorporate them because he 'doubts that laws of nature have as much of a special status as has been thought'. However, the status that they do have is not arbitrary. It can be shown why they 'tend to be cotenable' (i.e.first bullet) with counterfactual suppositions
- Adopts F.P. Ramsey's theory of lawhood:
    - **laws are 'consequences of those propositions which we should take as axioms if we knew everything and organized it as simply as possible in a deductive way'**
    - regardless of what we know, there exist innumerable true deductive systems: deductively closed, axiomatizable sets of true sentences
    - some of these systems can be axiomatized more *simply* than others and some have more *strength/*information content. These virtues tend to conflict – pure logic is simple but not strong
    - We value a balance of simplicity and strength
    - Thus a restatement of the theory of lawhood is: **a contingent generalization is a law of nature if and only if it appears as a theorem/axiom in each of the true deductive systems that achieves a best combination of simplicity and strength**
    - A generalization is a law at a world i, if and only if it appears as a theorem in **each of the best deductive systems true at i.**
    - Science gives us vague guidelines for assessing the combinations of strength and simplicity on offer, as well as probability of truth. If we knew everything truth would not be a consideration, though strength/simplicity still would
- This theory succeeds in explaining six facts about laws of nature:
    1. Lawhood is not simply a matter of the generality of the sentence, but rather **which sentence/s fit best with other truths to make a best system**
    2. Lawhood is contingent. A law can be true in one world and not in another because other truths that place it in a best system are not present in the other world
    3. It explains how we can know by **exhausting instances that a generalization is true, but not that it is a law**
    4. Being a law is different to being regarded as a law. Duh. Also allows laws to exist which we have no inkling of.
    5. Explains why we may take provisional scientific theory as law - science is the attempt to find the best deductive systems with best combination of simplicity and strength
    6. **Lawhood seems a vague concept, because our notions of strength and simplicity are only roughly fixed**

- Of course, one limitation is that the historian necessarily comes from preconceived notions of rationality and principles
    - To some extent these must be used if we are to understand the calculating framework at all; otherwise we will be unable to work towards the foreign data

Philosophy of Science - The Central Issues

Six Kuhnian Arguments for Relativism

- Theory-ladenness of observation
    - What scientists observe depends upon the theories they accept
        - is this the fallacy of equivocation? The object observed is not equivalent to X's beliefs about it (but surely Kuhn isn't claiming this: the object is the same, but what is seen, and the relations it is placed in, are different, hence they see different things)
    - No proponent of a scientific theory can ever observe anything contrary to that theory
        - patently a poor reading of Kuhn; anomalies
- Meaning-variance
    - In order for this thesis to support Kuhn's denial of rationality and progress, it would have to entail that scientists committed to different paradigms speak different languages
    - Insofar as comparisons between theories involve logically valid arguments, meanings must be fixed throughout. If Newtonian mechanics can be derived from Einstein's mechanics, then meaning must be fixed. Kuhn rejects this
    - Is it contradictory to claim that rival paradigms are incommensurable yet it is impossible to believe both at the same time? If they mean different things…
- Problem weighting
    - Theories should be assessed not by their empirical or observational consequences, but by seeing how good they are at solving problems
    - Fitting theories to agree with observation is easy, if you don't care what the theory looks like
    - This problem solving is the unit of scientific achievement
    - But no paradigm can solve all problems, so we are left to choose which puzzles are most important to solve
- Shifting standards
    - Paradigms include standards for assessing theories, and these vary
        - e.g. novel predictions, unified explanations
- The ambiguity of shared standards
    - The standards we do agree upon may be open to interpretation e.g. simplicity, consistency
- The collective inconsistency of rules
    - Accepted standards may conflict

McMullin's Criticisms of Kuhn

- Post *Structure*, Kuhn seems to have moderated his relativism
    - paradigm debate can be rational insofar as it is based on shared values
- Yet he still claims that no objective notion of progress can be applied across revolutionary divides
    - it is impossible to show that the values that act as a criteria are connected in any necessary way with truth or verisimilitude
- **Shared values**
    - Kuhn allows that revolutions can shake all of science e.g. Newton, or else a small

backwater e.g. X-rays
    - For the less consequential revolutions, maybe shared values are unaffected, but surely big revolutions involve debates about standards
    - Kuhn rejects the idea that science has a fixed essence, or set of necessary and sufficient conditions to distinguish it from other disciplines, identifying it instead as Wittgenstein does cluster concepts
    - But if this is the case, why shouldn't the 'shared values' of science change over time?
- **The justification of values**
    - Although we cannot prove the connection between epistemic values and truth, we can demonstrate the connection between simplicity, fertility and predictive reliability and explanatory success
        - prior to Copernicus, it was believed that theories couldn't give both reliable predictions and good explanations
        - thus maybe we can justify our use of these values by appealing to lessons of history and experience (question begging regarding induction?)
- **Rationality and Realism**
    - McMullin disputes Kuhn's rejection of scientific realism
        - Kuhn claims that the Ptolemaic and Copernican theories had about the same predictive accuracy
        - McMullin suggests that whilst predictive accuracy is similar, Copernican could explain far more phenomena (surely Kuhn acknowledges this, but claims explanation is paradigm-bound? Ptolemaic theory could have 'explained' the same things with any collection of sentences)
        - 'Kuhn's instrumentalism makes him unwilling to recognize the important distinction between prediction and explanation' - McMullin argues that explanatory power is an indicator of truth
        - Copernican theory's fertility in important lines of research can be valued on epistemic grounds, as an indicator of truth. 'Only a theory that is true or close to the truth could possible be successful in producing such a cornucopia of wonderful new results.'

Laudan's Criticisms of Kuhn

- Laudan is not a scientific realist, so he evaluates Kuhn's claims at the level of problem solving
- Cites two distinct models of scientific rationality:
    - Hierarchical model - paradigms have three components: the factual, the methodological and the axiological. Factual includes conceptual framework, account of entities that populate the world, and particular theories; methodological includes specific directives regarding methods of experimentation, rules about what constitutes confirmation of a theory, and principles regarding the values of science e.g. 'prefer simpler theories'; axiological includes the aims and goals of science. Factual disagreement is resolved by appeal to methods, methodological disagreement resolved by appeal to axioms. Axiological disagreement cannot be resolved rationally
    - Reticulational model - antiholistic and nonlinear. Paradigms can be divided into components and accepted or rejected piecemeal. Also, changes at one 'level' do not have

emerire regularity isn't a law?)

A full-blooded view - nomic necessitation

- Nomic necessitation sees laws as relations between universals, where universal = properties and relations that can apply to more than one object
    - a first order universal is a property of or relation among particular things (e.g. greenness)
    - a second order universal is a property or relation among first order universals (e.g. being a colour)
        - on this view, nomic necessitation is where one first order universal implies another (e.g. being magnesium necessitates being combustible in air)
- This solves the problem of accidental regularities - if Fness necessitates Gness then every F will be G
- This also puts a space between laws and its instances - the fact of Fness necessitating Gness is independent of F being G
    - this allows explanation
- Allows induction - if we observe a relation between entities, we can posit a relationship of necessitation between two properties
    - we induce not only a resemblance of unobserved and observed cases, but rather a relation of two properties, which allows the resemblance of unobserved and observed cases
        - Grue, emerire difficulties are solves because they are not properties

What is necessitation?

- Armstrong claims its conditions are:
    a. if Fness necessitates Gness then this entails that everything which is F is also G
    b. the reverse entailment does not follow. Instances of Fness may only coincidentally also be instances of Gness, without there being any necessitation
    c. Since necessitation is a relation, it is a universal. Furthermore, since necessitation is a relation among universals, it is a second-order universal
    d. Since necessitation is a universal, it has instances. Its instances are cases of, for example, a's being G because a is F (a's being F necessitates a's being G)
- But actually this doesn't distinguish nomic necessitation from Ramsey-Lewis' systematic account. For RL:
    a. all Fs are Gs
    b. the above is an axiom or theorem of that axiomatic system which captures the complete history of the universe and is the maximal combination of strength and simplicity
        - Armstrong's a) and b) are met by RL's a) and b)
        - RL is a relation among properties, as is necessitation
        - Armstrong's d) is equivalent to instances in the RL model, where A is G because A is F
- Because this account of necessitation can be made equivalent to an account of regularity, it cannot help us account for the metaphysical features of laws:
    a. a law explains its instances
    b. particular facts can count as evidence for there being a law
    c. it is possible for systematic regularities to diverge from the laws that there are (there can