LAWS AND INDUCTION (2000)

Here is how a prominent physicist, Steven Weinberg, recently expressed his belief in the existence of laws of physics:

"I have come to think that the laws of physics are real because my experience with the laws of physics does not seem to me to be very different in any fundamental way from my experience with rocks. For those who have not lived with the laws of physics, I can offer the obvious argument that the laws of physics as we know them work, and there is no other known way of looking at nature that works in anything like the same sense."

Recent philosophical discussions of laws of nature are somewhat more sophisticated if not more solid than Weinberg's comparison with rocks. They are the subject of this talk.

Among those who (like Weinberg) think that laws of nature are real there are two very different accounts of what they are. I will call them "the Metaphysical Conception" and "The Humean Conception". These terms are not intended to be either pejorative or historically accurate. The fundamental difference between the two conceptions is that the metaphysical view conceives of laws as involving necessary connections and as in some way governing or guiding the evolution of events. In contrast, Humeans deny the existence of any kind of necessary connections and think of laws as summarizing rather than as governing or guiding. On Humean accounts fundamental laws are uniformities involving categorical properties; i.e. properties that are not themselves individuated (partially or entirely) in terms of nomic (or causal) connections. (Higher level laws may involve non_categorical e.g. functional, properties). Different Humean accounts differ on what further conditions a uniformity must satisfy to qualify as a law but all agree on the following two claims. 1. The fundamental properties that constitute the world are categorical and 2. Any world exactly like ours with respect to its categorical facts is also exactly alike it with respect to its laws. This latter claim is an instance of a doctrine that David Lewis calls "Humean Supervenience." That doctrine says that all the nomic features of the world_ features involving laws, counterfactuals, chances, and causation_ supervene on the totality of categorical facts. Any world that minimally duplicates the categorical facts that obtain at our world also reproduces all its nomic facts.

The metaphysical conception of laws has been articulated in two ways involving different accounts of the nature of necessary connections. On what I will call Necessitarian accounts (associated with Sellars, Shoemaker, Swoyer) necessary connections are built into the essences of properties. Necessitarians thus reject 1 holding that the properties that appear in fundamental laws are individuated, either wholly or partially, in terms of these laws.1 It follows that a true statement expressing a law is necessarily true; where the modality is the same as logical necessity; i.e. true in all possible worlds. The other view is that a law is a contingent fact involving a sui generis connection between categorical properties; N(F,G). I will call it the "ADT" view after its most prominent advocates (Armstrong, Dretske, and Tooley). Armstrong says that this connection is one of contingent necessity. What he means by this is that while whether a law obtains at a world is a contingent matter the nomic connection he posits is produces a kind of necessity_ though lower grade than logical necessity_ since it endows laws with the capacities of explaining the facts they subsume and of supporting counterfactuals. The ADT account agrees with Humean accounts in holding that fundamental laws involve categorical properties but differs from Humeanism in positing necessary connections and thus rejecting the supervenience thesis 2. I will call the laws characterized by either the Necessitarian or the ADT view M_laws.

There are some interesting differences between Necessitarian and non_Necessitarian accounts of M_laws. As I mentioned, on Necessitarian accounts if it is a M_law that Fs are followed by Gs then it is logically necessary that Fs are followed by Gs. The apparent contingency of laws is explained by noting that it is a contingent matter whether the law is instantiated. And the a posteriority of laws is explained by the fact that we usually conceive of the properties constitutive of the law via contingent modes of presentation; e.g. the property actually responsible for such and such effect. In contrast, on the ADT account M_laws are genuinely contingent. It follows that there can be two possible worlds exactly alike in their distributions of fundamental properties though differing wrt their laws. This is clearly not possible on Necessitarian accounts since fundamental properties have nomic commitments. It follows that worlds that agree on their distributions of fundamental properties must agree on their laws. On the other hand, the Necessitarian view allows for the possibility of worlds that are isomorphic wrt their distributions of fundamental properties though differing in what these properties are and so in their laws. Also on non_Necessitarian accounts Humean worlds_worlds with no M_laws_ are possible. Obviously Necessitarian accounts preclude this possibility. So the ADT account allows for more possibilities than its Necessitarian cousin. One may question_as Shoemaker does_ whether these possibilities are real or_if they are_whether we can ever distinguish among them.

There are puzzles concerning both the ADT and the Necessitarian views. The notion of a categorical property_an entity shorn of nomic commitments is quite puzzling. If, e.g. charge and mass are fundamental properties and if they are categorical then it is metaphysically possible for them to exchange roles in laws while maintaining their identities as properties; i.e. they are bare universals. But this raises the question of what distinguishes one fundamental property from another. Are they merely numerically distinct as Armstrong has recently suggested? (This is a problem Humean accounts share with the ADT view since they also require that fundamental properties are categorical). Further, there is the problem of explaining how the fact that two properties are connected by nomic necessitation_ N(F,G)_ entails the associated general fact Fs are followed by Gs. On the ADT account_ unlike the Necessitarian account_a law is a distinct fact from the generalization it backs. By what mechanism does the law bring about the generalization? At one point Armstrong just says that it does and that we must accept this with an attitude of natural piety. An ironic concession from an avowed naturalist.

The puzzle for Necessitarians is whether their view is coherent at all. It has been argued (Russell, Foster, Armstrong, Blackburn) that if all properties are individuated in terms of their nomic connections then the world becomes all potency and no act. Russell compares the situation with one in which everyone takes in everyone else's washing. Presumably, he is suggesting that in this case no washing will ever get done. Blackburn says that if all the fundamental properties are dispositional then it follows that "nothing happens." He calls this "the no washing argument." I myself don't find this argument sufficiently clear to evaluate it but I suspect it doesn't wash! It seems that God could create a world out of nomically individuated properties as long as he respects their nomic commitments in distributing them throughout space and time.(Can spatio_temporal relations also be individuated nomically?) What properties are instantiated may vary of time so, as far as I can see, such a world may be eventful. Be that as it may I will not say anything more about the differences between the two versions of the metaphysical view since I am mainly interested in an argument that proponents of both versions use against Humean accounts.

Metaphysical views have, as we have seen, their difficulties. But their proponents think that these difficulties are minor compared to the problems faced by Humean accounts. They are one in claiming that Humean laws are at best a pale imitation of the genuine item and are incapable of doing the work that laws are required to do. There are various arguments that they bring to bear to show this. The one I will focus here on attempts to establish that Humean accounts of laws and causation_ and more generally Humean Supervenience_ leads to inductive skepticism. Armstrong thinks it is no accident that Hume (at least on standard text book accounts) both denied the existence of necessary connections and propounded inductive skepticism. I will argue to the contrary that there is no necessary connection between the two issues. But prior to that I want to briefly describe what I take to be the most sophisticated Humean account so far developed. This account is due to Mill, Ramsey, and most recently, David Lewis (MRL). On the MRL account a contingent generalization_ differential equation etc._ expresses a law iff it is a theorem of the best theory of the world. Here is what Lewis means by that. Think of a possible world as being characterized in terms of the history through all space (or space_time or whatever the arena in which events occur) of the instantiation of fundamental (categorical) properties and quantities. All the candidates for best theories are formulated in a language whose simple predicates in addition to those of pure mathematics, express spatio_temporal relations and fundamental properties and quantities. Lewis calls these fundamental properties "perfectly natural." The goodness of a theory is measured in terms of simplicity a and informativeness. Simplicity is measured in terms of the simplicity of its simplest axiomatization which in turn depends on considerations like number of independent parameters, order of differential equations, and so on. Lewis doesn't provide a detailed account of simplicity but seems to suggest that scientific practice is sufficiently robust to determine a simplicity ranking. Informativeness is measured in terms of the logical strength of its implications. The more it says about the instantiation of fundamental properties the more informative. Note that often simplicity and informativeness trade off against each other. A theory T that doesn't entail a statement S can be made more informative by adding S as an axiom but the cost in detracting from simplicity will typically result in a theory T* that is not as good (on Lewis= ranking) as T. Lewis extends his account to accommodate chances by including probabilistic theories among those vying for the title best. So, for example, certain versions of quantum mechanics assign chances to the various possible ways in which a system in a specific quantum state may evolve. For such theories we must also ask how well they fit the world. Lewis suggests that this can be measured by how likely the world history is on the theory. Clearly by trading informativeness for fit great gains in simplicity can be achieved. For example, the "theory" that a long sequence of outcomes of coin tosses is a Bernoulli sequence with chance 1/2 is very simple and might be a very good fit while informative descriptions of the sequence will generally be very complex.

On Lewis's accounts laws and chances supervene on the totality of categorical facts. Counterfactuals are brought into the picture this way: A>B is true iff there are A&B worlds that are more similar to the actual world than any A&_B world. At first the truth conditions may seem to violate HS since they seem to say that the truth maker of A>B involves going on in other worlds. But in fact this is not so. According to Lewis; similarity to the actual world is measured in terms of perfect match wrt fundamental categorical facts and the extent to which actual world laws are violated. Since both of these factors depend only on categorical facts (in Lewis' view) it follows that counterfactuals are Humeanly supervenient. On the resulting account Laws support counterfactuals in the sense that if Fs are followed by Gs is a law then if the counterfactual supposition Fa is co_tenable with the law the counterfactual Fa>ExGx is true. Lewis then characterizes causal dependence and causation in terms of counterfactuals and event distinctness. That account also satisfies HS. Since laws support counterfactuals they also ground causal relations..both specific and general. I will call the laws delivered by the MRL account L_laws. Assuming that the fundamental properties are categorical and that vagueness in the account can be removed there is no doubt that the world contains L_laws. Further, there can be no doubt that knowing the L_laws of our world would be knowing something very interesting. Someone who knows the L_laws will be in possession of a relatively simple summary of the vast mosaic of facts. And it is plausible that science with its emphasis on theories that are informative and simple aims to learn the L_laws.

I greatly admire Lewis's efforts on behalf of Humean accounts. They are a tour de force. If correct they would enormously clarify nomicity and do so within the framework of a relatively unmysterious metaphysics (except for the bit about fundamental properties being categorical). That said, I must admit that I am far from sure that they or any Humean accounts are correct. My primary doubts involve the Humean presupposition that fundamental properties are categorical (a presupposition that is shared by the ADT account). It seems more natural to think of the best candidates we have for fundamental properties__quantum field values, gravitational field values, etc. as individuated in terms of fundamental laws; that is as the Necessitarian specifies. But if we grant that the fundamental properties are categorical then I think that Lewis' view_ or suitable developments of it_ can be successfully defended against anti_Humean arguments.

One objection to Lewis' account is that L_laws don't support counterfactuals. But it is clear that L_laws support L_counterfactuals. If it is an L_law that Fs are followed by Gs then as long as a's being an F is cotenable with the law the L_counterfactual "if a were an F it would be followed by a G" will be true. Of course an anti_Humean might counter that L_counterfactuals are not genuine counterfactuals but that needs independent argument. Another objection involves thought experiments which are claimed to show that laws (same for causal relations and chances) can vary independently of the categorical facts. For example, we can apparently imagine worlds identical with respect to categorical facts and that contain X and Y particles that never interact but one world is governed by the law that if they interact the annihilate each other and the other world contains no such law. While I think these thought experiments do tend to show that our nomic concepts violate HS I don't think that they show either that HS is false or if it is true then there are no laws (causal relations, probabilities). It is a mistake_one that philosophers are too often guilty of making_ to draw definitive conclusions about the nature of things from an examination of concepts (though of course conceptual investigations have a role to play). It can be argued_ I have so argued elsewhere_ that these thought experiments rely on our thinking of laws as governing the evolution of events. It is plausible that this metaphor has more to do with theological considerations that influenced the origins of the concept of scientific law than with any scientific considerations. I argued, as does Lewis, that laws needn't govern to support counterfactuals, ground causal relations, or provide explanations; i.e. to do the work that science demands of laws.

However, there is another objection that anti_Humeans make against Humean accounts_ that many think is definitive. The objection is that Humeanism is unable to account for the role of laws in inductive inference. This objection goes back at least to Kant and among its more recent advocates are Galen Strawson, John Foster, Fred Dretske, and David Armstrong. Armstrong puts it "if laws were Humean then induction would be irrational." He means both that the Humean would be irrational to make inductions and that if our world were Humean induction would be irrational for everyone. The denial of necessary connections leads to inductive skepticism. On the other hand, proponents of M_laws claim that they hold the key to solving Hume's problem of induction.

Since Armstrong has articulated the anti_Humean argument most extensively let's look at his version:

I start from the premise that ordinary inductive inference, ordinary inference from the observed to the unobserved is, although invalid, nevertheless a rational form of inference. I add that not merely is the case that induction is rational, but it is a necessary truth that it is so...We need an explanation of the rationality of induction. My own explanation is this. The sort of observational evidence which we have makes it rational to postulate laws which underlie, and are in some sense distinct from, the observational evidence. The inference to the laws is a case of inference to the best explanation...the inferred laws entail conditional prediction about the unobserved (if it is an F, then it will be a G)...Suppose however, that laws of nature are conceived of as mere Humean uniformities. Then, I contend, this explanation of the necessity of the rationality of induction must fail. On that view, the law is nothing more than the conjunction of its observed manifestations with its unobserved manifestations. Such a law is not an explanation of the observations. .....To tie up the argument it is necessary to ask why inference to the best explanation is rational. But that I think is analytic in a fairly obvious way. If making such an inference is not rational, what is? It may still be asked why the inference to underlying laws is the best explanation of our inductive evidence. The only answer to that is to challenge the questioner to find a better explanation. (P53 What is a Law of Nature).

The heart of Armstrong's argument is this: when we inductively infer that not yet observed Fs will be followed by Gs on the basis of the evidence of having observed a large number and wide variety of Fs having been followed by Gs in two steps. First, we abductively infer from the evidence that it is a law that Fs are followed by Gs. From the law we deductively infer that unobserved Fs will be Gs. The first inference is the one that interests us. Armstrong says that it is an inference to the best explanation; abduction. He claims that the law is the best explanation of the evidence. But, and this is the crucial step, only laws metaphysically construed are explanatory. Humean laws do not explain, at least not in the way required by abductive inferences. Armstrong explains why in the following passage:

Suppose, however, that laws are mere regularities. We are then trying to explain the fact hat all observed Fs are Gs by appealing to the hypothesis that all Fs are Gs. Could this hypothesis serve as an explanation? It does not seem that it could. That all Fs are Gs is a complex state of affairs which is in part constituted by the fact that all observed Fs are Gs. All Fs are Gs an be rewritten as ALL observed Fs are Gs and all unobserved Fs are Gs. As a result, trying to explain why all observed Fs are Gs by postulating that all Fs are Gs us a case if trying to explain something by appealing to a state of affairs part of which is the thing to be explained. But a fact cannot be used to explain itself. And that all unobserved Fs are Gs can hardly explain why all observed Fs are Gs. (P40)

If Armstrong's argument above is sound then he has shown that Humeans cannot appeal to inference to the best explanation to explicate inductive inference and if IBE is the primary form of scientific inductive inference they cannot explain why inductive inference is rational (let alone that it is necessarily rational.) But, he says, a proponent of metaphysical laws can construe inductive inferences (of the kind we are considering) as IBE and since IBE is analytically rational__ "if it isn't what is?"_ he has an explanation of the rationality of induction. Q.E.D.

Armstrong's charges against Humeanism are the following:

1. If someone believes that the world is Humean_that there are no M laws_ then that person cannot rationally use IBE in making inductive inferences. Since IBE is the only rational form of inductive inference the Humean's inductive inferences are not rational.
2. If the world were Humean then to the extent that inductive inferences were successful that would be a matter of luck. But if there are M_laws they would account for the success of inductions employing IBE.
3. So if the world were Humean inductive inferences would be irrational and one should (rationally) be a skeptic about induction. But if the world is governed by M_laws then using IBE is rational and "Hume's Problem" is solved.

If these charges are valid then Lewis' account of laws_ and any Humean account_ would be in deep trouble. A thinker who believes that the world is Humean would be irrational to make inductive inferences and/or would have no explanation for the success of inductions.

However, none of the skeptical conclusions that Armstrong draws about induction follow from Humean accounts of laws. I will argue that Lewis' Humean account of laws is compatible with the induction and can be used as an ingredient in a new "vindication" of induction. Let's first look more closely at Armstrong's argument. His assimilation of the inference from instances of a generalization to a law is, on reflection, a bit peculiar. IBE is usually invoked when inferring to a cause. For example, galaxies are found to be receding from each other. The best explanation is that the matter in the galaxies was once concentrated in a volume that exploded in a big bang. Laws are involved in this explanation in the background that make the big bang hypothesis "the best explanation" but no law is the conclusion of the inference. The inference to a law is not a causal inference but an inference from a correlation of properties to a law that explains the correlation. Armstrong sometimes seems to think that this explanatory relation is akin to causation but, of course, it cannot be since the law, on his account, is a timeless fact_ the fact that two universals are related by "contingent necessitation"_ and that fact isn't a candidate to be a cause. 2 Even so, it does seem that subsuming a correlation under a law goes some distance, if only a small distance, towards explaining the correlation in that it distinguishes it from mere accident.3 In any case, Armstrong thinks that Humean laws don't explain even in this sense. But his argument that Humean regularities don't explain doesn't obviously apply to Lewis' account of laws. Armstrong says that a mere regularity cannot explain one of its instances since it is a conjunction of that instance with others. But the Humean can reply that what explains is not the regularity but the proposition that the regularity is an L_law. And that proposition is not merely a conjunction of observed and unobserved instances. Rather, it asserts that the proposition Fs are followed by Gs is a consequence of a best theory. That is a much more sophisticated claim and it is far from obvious that it doesn't possess explanatory force. On one of the main accounts of explanation explanations work by unifying events; revealing important and simple patterns among them. Subsumption under an L_law by partly specifying how the subsumed events fit into the best theory_ the theory that earns that title by providing the optimal unification of fundamental categorical facts.

In view of this Armstrong cannot simply seize the high ground and announce that M_laws explain while L_laws do not. But some of his remarks suggest that he thinks that even if there is a sense in which L_laws explain they do not explain in a way can underwrite an IBE. So an inference from Fs being followed by Gs to it is an M_law that Fs are followed by Gs is an instance of IBE because the latter explains_ in the relevant sense_ the former. In contrast, an inference from instances of Fs being followed by Gs to the claims that it is an L_law that Fs are followed by Gs is not an instance of IBE since L_laws don't explain in the relevant sense. However, I will argue that the only way Armstrong can maintain that induction is irrational for the Humean is if IBE is a form of ampliative inference that is incompatible with Bayesian inference_ more specifically with the likelihood principle. In other words, the following conditional is true:

**) if IBE is compatible with Bayesian inference then if IBE inferences from observed instances of a generalization to not yet observed that go via M_laws is rational then IBE inferences that go via L_laws are rational.

Here is the argument for (**). Suppose that inductive inference can be represented within a Bayesian framework. Consider two scientists Arm and Lew. Arm believes that there are M_laws and assigns positive prior probabilities to some propositions expressing M laws (and of course at least as great probability to the generalizations they back). Lew thinks there are no M_laws and so assigns 0 prior probability to propositions expressing M_laws. However, Lew's subjective probability assignment on the purely categorical propositions, including generalizations that Arm thinks are backed by M_laws, is exactly the same as Arm's. In particular, for any generalization H such that Arm assigns a positive probability p to an M_law proposition that entails e Arm and also Lew will assign a probability of at least p to H. The result, of course, is that if Lew and Arm obtain the same evidence and conditionalize on it (i.e. update their degrees of belief in conformity with Bayesian inference) the posterior probability distributions wrt categorical propositions will be exactly the same. If evidence e confirms H for Arm it will also confirm it for Lew. Further, if their utilities wrt categorical propositions are the same their behavior as scientists_ what experiments they design_ which hypotheses they chose to test etc._ will be identical. So how can it be that Arm's inferences are rational while Lew's are not?

I can think of three responses that Armstrong might make to this argument. 1) Reject the assumption that IBE is compatible with Bayesian inference and hold that it not Bayesian inference is rational; 2) Accept that IBE is compatible with Bayesianism but claim that Lew's probability distribution while coherent fails to satisfy some other constraint required by IBE; 3) accept Lew's inferences are an instance of IBE but argue that the existence of M_laws is required to account for the success of IBE so Lew has no explanation of why his inductions are successful (to the extent they are) while Arm can explain this success. (One might think that Lew's beliefs are not completely rational just because he can';t explain the success of his inductions.)

Whether or not IBE and Bayesian inference are compatible isn't all that clear mainly because exactly what constitutes IBE is not all that clear. Peter Lipton in his recent book on IBE doesn't even address this issue. Harman, who I think introduced the expression IBE into current discussion, seems to take the likelihoods P(e/H) as measuring how well H explains e. So understood IBE is perfectly compatible with Bayesian inference. However, the notion of explanation involved on this construal is very weak and probably not what many advocates of IBE_ certainly not Armstrong_ have in mind since it implies that any hypothesis that entails e explains it. There is a somewhat more robust Bayesian construal of IBE that builds explanitoriness into the prior probabilities of hypotheses. The idea is that there are certain hypotheses that are suitable to be explanatory (perhaps this is a matter of degree) in virtue of their simplicity or positing underlying causal mechanisms or some such. Subjective probabilities are then constrained by the following rule

Bayesian IBE: assign degrees of belief so that explanatory hypotheses are instance confirmed and any hypothesis that is instance confirmed is explanatory or its being instance confirmed is entailed by some explanatory hypotheses being instance confirmed. (e instance confirms H iff e confirms H and P(e*/e) > P(e*) where e* is an arbitrary not yet observed instance of H.)

Understood this way IBE supplements Bayesian inference by placing a requirement on prior probabilities. Exactly what this requirement comes to depends on exactly how "explanatory" is understood. I am not sure that there is substantive notion of explanation that yields a plausible assignment of prior probabilities. It may be that the rule has things backwards_ our judgements about which hypotheses are explanatory are parasitic on our probability distribution. In any case, I think that the above is the best that can be done_ or the best I can do_ to represent IBE within the Bayesian framework. But if IBE can be represented in this_ or some other way_ in the Bayesian framework then it looks as though it follows that Lew's inferences to L_laws is at least as rational by IBE as Arm's inferences to M_laws_at least as long as L_laws are counted as explanatory.

Armstrong might deny that what he has in mind by IBE can be represented within a Bayesian framework in the way I suggested or any other way. He doesn't (and as far as I know no one else has either) propose a specific IBE rule but we can ask what would such a rule of inference look like? Van Frassen_admittedly no friend of IBE_ suggests the following. Let H and H* both entail e and both have the same initial degree of belief but H explains e much better than H* does. In that case IBE says that if we observe e our degree of belief in H (and its further instances) should go up much more that our degree of belief in H*. This rule is genuinely incompatible with Bayesianism. It violates conditionalization and more generally it violates the likelihood principle. The trouble with this is that someone who follows an inference rule like the one above that violates conditionalization is subject to standard Dutch book arguments. And even if you don't find these arguments persuasive one should think twice before violating the likelihood principle which seems about as intuitive as anything gets in inductive inference. To paraphrase Armstrong "if the likelihood principle isn't rational what is?"

The second reply is that Lew's probability distribution is not rational. Armstrong could assert that Lew's probability distribution doesn't genuinely conform to Bayesian IBE since Humean regularities that are not backed by M_laws are not explanatory. So Lew, if he conforms to Bayesian IBE, should assign L_laws 0 priori probability. But this assertion is question begging in the present context. Is there any argument for it? The only argument I know of is one suggested by Armstrong's explanation of why he thinks Humean regularities are not explanatory and is more explicitly advanced by John Foster and Galen Strawson. It is that someone who thinks that the world is Humean_ that there are no necessary connections among events_ should (rationally) consider those events to be probabilistically independent; i.e. as if its instances resulted from something like random draws with replacement from an urn. If this were correct then for a Humean no generalization with unlimited scope would be confirmable. But it is simply a mistake to equate the Humean view that there are no necessary connections in nature (that laws supervene on the distribution of categorical facts) with the proposition that events are probabilistically independent. And in the next section I will show how a Humean can motivate a probability distribution which does permit the confirmation of laws. I know of no other argument that the Lew's probability distribution is irrational.

It might be objected (it was when I read an earlier version of this paper at Stanford)that my argument that Lew is as rational as Arm can't be correct since an analogous argument could be used by an instrumentalist (constructive empiricist), to argue that her probability distribution is as rational as a scientific realist's probability distribution. And while some philosophers will not find that objectionable many others think that there is something not rational about not inferring the existence of unobservable entities that play a role in explaining observations. I don't want to take sides on this question (though I admit my sympathies are mostly with the scientific realist) but I do want to point out that the situation is quite different here than in the case of M_laws. Let's suppose that Dick is a scientific realist assigns positive probability to some hypotheses entailing the existences of unboservables as well as many statements about observables and that Van is a constructive empiricist whose probability distribution is just like Dick's with respect to statements about observables but assigns 0 degree of belief to every specific hypothesis entailing the existence of unobservables. As far as confirmation relations involving propositions concerning only observables are concerned Dick and Van are identical. So one might suppose that if Dick's confirmations are rational then so are Van's. This is likely to strike some_ particularly scientific realists_ as mistaken and so cast doubt on my counter argument against Armstrong. However, there is an important and instructive difference between the two cases_realism about M laws and realism about unobservables. The difference is that Dick_ the scientific realist_ can argue that Van's probability distribution is not rational_ or not as rational as Dick's_ at least not by the cannons of scientific methodology. In particular Dick's beliefs (or degrees of belief) about unobservables will systematize his beliefs about observables. Van may have high degrees of belief in various observational laws but these will be unconnected. In contrast, Dick may be able to derive these laws (and their (probabilities) from beliefs about unobservables. Unification of this sort is an aim of scientific theorizing and it is not implausible to say that unification even when it involves positing unobservables brings gains in rationality. The situation with M_laws is quite different since posting them does not bring any greater systematization.

3) grant that Lew's inferences are as rational in the sense of being as successful as Arm's but claim that the reason they are successful is that the world contains M_laws. Even though the Humean doesn't believe that there are M_laws it is they that accounts for their successful inductions. Without M_laws successful inductions would be miraculous_without explanation. If this is right then there is a sense in which Arm's belief system is more rational that Lew's since he can account for the success of induction while Lew cannot.

But this complaint against Humeanism is obviously question begging. Lew can explain why his inductions are successful as well as Arm can. Of course his explanations will appeal to L_laws_ perhaps the L_laws of evolutionary biology and cognitive psychology as well as physics. Unless Arm can show that these are not genuine explanations his objection falls flat.

Armstrong sometimes suggests that by positing M_laws we can somehow solve Hume's famous Problem of Induction. One way of understanding Hume is as arguing that there can be no non_question begging justification of any form of ampliative inference. If justification means showing that a method of ampliative inference leads from true beliefs to true beliefs all or most of the time then Hume did demonstrate, as convincingly as anything in philosophy, there can be no non_question begging justification. The existence of M_laws or belief in their existence can provide no help. Since the M_laws are contingent_ or it is contingent which are instantiated_any observational evidence we obtain will be compatible with infinitely many different M_laws. So any ampliative rule that leads us to true beliefs about the M_laws that works in our world wont work in others. Knowledge that our world is one in which a particular ampliative method will lead to true beliefs itself requires inductive justification. This is so whether or not there are or one believes there are M_laws!)

If my reasoning to this point is sound then I have shown that arguments advanced to demonstrate that Humeans about laws must be skeptics about induction are unsound. The rationality of induction doesn't depend on belief in the existence of M_laws and the success of induction doesn't depend on the existence of M_laws. In fact, I think that a rather interesting_ if not completely plausible_ vindication of induction can be constructed on the basis of Lewis' account of laws. I will conclude by briefly sketching it.

By "vindication of a particular method relative to some goal" I mean an argument showing that if it is possible to attain that goal at all it is attainable by that method. This is what Reichenbach, Feigl, and Salmon had in mind when they tried to vindicate the so called "straight rule" for estimating probabilities. The goal I have in mind is discovering the L_laws and more generally the Lewisian Best theory of our world. As we observed earlier it is plausible that one of the aims of physics is the discovery of informative, simple, and well fitting theories. The method I have in mind is Bayesian inference with certain qualifications.

I will call a possible world "Physics Friendly" if there is a Best theory of the world couched in the language of physics that is relatively simple and informative (or if indeterministic fits well). What I will argue is that if our world is physics friendly then Bayesian inference...will almost certainly lead us_ as evidence accumulates closer and closer to the true best theory of our world. Consider the collection of candidates for Best theories of our world. Such theories would have to agree with the obvious facts about our world, would have to be relatively simple, and potentially relatively informative. They would not have to be true _ since they are just candidates_ but they would have to say a lot about what they take to be the instantiations of fundamental physical properties. The first claim I want to make_ on which my vindication depends_ is that either there are only finitely many such Best theories or, if there are countably infinitely many they fall into finitely many classes of similar theories (i.e. theories that differ only in the value of some parameter). The reason is that a Best theory is simple and being simple means that it can be written down in a book of less than X pages and there are only finitely many such theories. [problem...that is so given a fixed vocabulary..but there are infinitely many possible vocabularies. Reply, no there are only finitely many since the terms obtain their meaning via the theory!] The second ingredient in my vindication is Bayesianism. Bayesian induction, whatever its limitations, does provide an ideal of inductive consistency. Let's call a prior probability distribution "Physics Appropriate" if it assigns positive probability to every candidate best theory _ or if there are infinitely many _ positive probability to every class of parametized Best theories (with that probability distributed among the theories in the class so that each theory obtains non_zero though perhaps infinitesimal probability). Physics Appropriate distributions may differ on the value they assign to their prior probability distributions but all assign positive probability to each theory that is a candidate for being a best theory of our world. Say that an experiment E with possible outcomes e and e* discriminates between T and T* iff P(e/T) =/= P(e/T*). Let's suppose that experiments can be performed and observations made that discriminate among the theories. Further, let I be the interval that contains for a particular Bayesian scientist the most likely candidate best theories such that the sum of their probabilities is .9. Then it is a consequence of the Bayesian convergence theorems that her subjective probability in the following proposition will be approach 1:

Ideally, I will ultimately contain a single theory_the true one. But it may very well be that our world is such that there are two (or more) candidate best theories one of which is true but which are indiscriminable. Perhaps Bohmian and Copenhagen quantum mechanics would be (if either were true) an example.

Can a proponent of M_laws_ should he see merit in the foregoing vindication_ make use of it? I think the answer is "yes" if he makes the assumption that the M_laws of the world will reveal themselves_ or are likely to reveal themselves_ in the L_laws. So far as I can see_ but I may not see very far_ there is no reason to think that this will be the case. It would have to be an additional assumption. The Humean physicist hopes that our world has a Best theory. The Metaphysical Physicist assumes this and in addition that there are M_laws behind the scenes_ as it were_ that give rise to the regularities summarized by the Best Theory. That last assumption strikes me as _ "merely metaphysical."

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1Shoemaker seems to hold that fundamental properties (including space/time properties and relations?) are entirely individuated in terms of laws (and causal relations if these are something over and above laws).

2If C causes E requires there to be a law subsuming C and E then it would appear that if the relation between an M_law and the correlation it explains is causal there must be a law subsuming the M_law fact and the correlation. Thus the first step is taken on an infinite regress. The regress may not be vicious but it certainly entails the existence of more laws then is credible.
3There is a difference between explaining the occurrence of an event by citing a law and another event which subsumes the events and explaining a correlation by citing a law that subsumes it. In the first case we are typically interested in causal explanation. Thus we explain the falling barometer in terms of the falling pressure and a law that falling pressure results in falling barometers. Of course, we cannot explain the falling pressure in terms of the falling barometer and the law since the falling barometer doesn't cause the falling pressure. In contrast we explain why there is a correlation between falling pressure and falling barometer by citing the law. This explanation is not causal.