NATURAL LAWS, UNIVERSALS, AND THE INDUCTION PROBLEM

Edward Slowik

One of the central problems in the philosophy of science concerns the ontological status of the physical properties, such as "blueness" or "mass", that constitute the laws of nature. The "Universals" theory attempts to resolve this dilemma by conferring a degree of existence to these properties: in other words, blueness is a kind of entity in its own right (which supposedly explains, as for Plato, why we can pick out the same property in many diverse objects not previously experienced). It is often claimed by the proponents of a theory of universals that scientific natural laws are particularly well suited to a universals treatment, especially as regards the separation of mere accidental regularities from "real" natural laws. The "induction" problem, as it is known, is a significant issue in the philosophy of science since our past experience of natural phenomena cannot rule out the possibility that our best natural laws (such as, "all electrons have negative charge") are only accidental regularities (in the same manner that, say, "all solid gold objects weigh less than 10,000 lbs." is only an accidentally or contingently true claim). Although the critics of the universals approach have devised many ingenious counter-arguments to undermine the universals theory, it would seem that they have been too quick to accept the universalists' claim to have resolved the induction problem. In this essay, we will explore this relatively neglected aspect of the universals theory debate, and, by way of a lengthy example, demonstrate that a direct assault on the universals account of physical properties, as it pertains to the induction problem, constitutes one of the most effective counter strategies.

In section 1, we will examine an instance of a generally inconclusive debate that apparently results from not questioning the central tenets of the universals theory as it pertains to the induction problem. The arguments that B. van Fraassen has aimed at D. M. Armstrong's conjecture on probabilistic natural laws will serve as our example. In short, Armstrong has attempted to reconcile probabilistic natural laws (i.e., laws which involve irreducible probabilities) with his principle of instantiation (that universals only reside in their particular instances). Van Fraassen has claimed that Armstrong's natural law project encounters serious obstacles with respect to this union, and that the problems generated should serve as the basis for a reappraisal of this theory. Overall, not only will Armstrong's theory be shown to contain sufficient resources to meet van Fraassen's challenge, but it will be argued that the very form of van Fraassen's critique is essentially limited and unfruitful. In section 2, we will examine the above mentioned alternative strategy of critiquing the universals project via the induction problem, a method which is not only more profitable, but which draws upon much recent work on the status of scientific properties.

1. Probabilistic Natural Laws and the Armstrong/van Fraassen Debate

Before assessing van Fraassen's arguments, we will need to summarize briefly the details of Armstrong's theory. In short, Armstrong conceives natural laws as contingent relations between universals. If the universals F-ness and G-ness are conjoined by a relation of *contingent necessitation,* then every instance of a particular F being a G will be explained via that specific relationship, which he symbolizes "N(F,G)". Thus, given any F, the existence of the universal N(F,G) guarantees that it is also a G. According to Armstrong, this explanation avoids the problem of induction which plagues most theories of natural laws. That is, how can one claim that "all Fs are Gs" constitutes a law based only upon the observation of past instances of Fs being Gs? Answer: natural laws possess universals which are of the N(F,G) form, while accidental regularities do not. (Returning to our earlier examples, thus "electron" (F) and "negative charge" (G) are an instance of N(F,G); while "solid gold objects" (F) and "weighs less than 10,000 lbs." (G) do not constitute an N(F,G) necessitation relationship.) Furthermore, Armstrong is careful to limit the instantiation of the law to only those cases wherein a particular F is a G. This thesis, commonly entitled "the principle of instantiation", rejects the view that universals can exist apart from their particulars: "No properties without things of which they are particulars. . ." (1988b, pp. 107-108).

Armstrong defines the structure of his probabilistic laws as, "((Pr:P)(F,G)) (*a*'s being F, *a*'s being G) where ((Pr:P)(F,G)) gives the objective probability of an F being a G, a probability holding in virtue of the universals F and G" (where "P" represents the probability value between 0 and 1; 1983, p. 128). He reckons that this law should be read as *"a*'s being F *necessitates a*'s being G, a necessitation holding in virtue of the fact that universal F and G give a certain probability, P, of such a necessitation" (1983, p. 132). Based on this claim, the above law can be provided the following alternative interpretation: ((N:P) (F,G) (*a*'s being F, *a*'s being G), where N is the necessitation relation among the particulars (as above) and P ranges between 1 and 0 (1983, p. 132). In addition, probabilistic laws also obey the principle of instantiation, since the law only applies to those cases wherein a particular F is a G: *"Probabilistic laws are universals which are instantiated only in those cases where the probability is realized"* (1983, p. 129).

One of the principle targets of van Fraassen's critique is this instantiation requirement, which he attempts to undermine by considering the example of an actual probabilistic law; namely, the probabilistic radioactive decay law e^{-At} (where "*e*" and "*A*" are constants, and "*t*" an arbitrary time interval). According to Van Fraassen, the "Armstrongian" formulation of this law reads: (Pr: e^{-At})(F,G); where "F" is "radioactive atom", and "G" symbolizes "remains stable (or decays) during a given time interval *t*" (1989, p. 111). Since Armstrong confines the existence of universals to their specific instantiations, it follows that there must always exist particulars to ensure the continuation of the natural law. Consequently, van Fraassen states that the radioactive decay law will require an existing atom for each value of the time interval *t*. There are two options, here: either a single atom remains continuously in existence, or an infinite series of atoms remains stable for all values of *t*. As for the first option, to insist that the physical world supply our theory a radioactive atom which never decays appears to be a rather contradictory demand (for radioactive atoms do decay). Van Fraassen considers the last option, "not even sensible, let alone possible," presumably because such requirements ask too much of a physical theory (1989, p. 358). The specific details of Armstrong's theory, specifically the instantiation principle, thus mandate a counter-intuitive choice of prerequisites that inevitably cast a long shadow of doubt across the universals project.

As suggested at the outset, the effectiveness of van Fraassen's critical method seems intrinsically limited, and this is particularly evident in his first attempt to subdue Armstrong's theory. Given the elaborate nature of Armstrong's universals ontology, there would appear to be ample resources to counter van Fraassen's argument—and this is exactly what Armstrong proceeds to do. With respect to the probability P, he advances the notion that it "gives us the probable limiting frequency *if the population is infinite"* (1988a, p. 226). In those cases where the population is not infinite, the law thus assumes a counterfactual status. Yet, what supports the counterfactual in those situations? Answer: "The actual [necessary] relation between the actual universals. Why should we not say that [the relation among universals] sets the probabilities for the infinite case, setting it as a limiting relative frequency, whether or not the relevant population is in fact infinite" (1988a, p. 226)? By this simple maneuver, Armstrong is thus able to elude those seemingly problematic aspects of his instantiation principle, such as requiring an infinity of radioactive atoms or a single radioactive atom that never decays.

This "infinite particulars" criterion, as we may call it, also protects Armstrong from the problem of determining the exact function of a probability value in those worlds where there exists only one particular to instantiate the law. More precisely, if a theory's probability value P is 3/4, but there is only one instantiation of the law, then the observed probability must be 1, and not 3/4, since the probability must be realized in this one case (in order to instantiate the law). Nevertheless, this quandary, which constitutes van

Fraassen's second counter-argument, is likewise defused by stipulating that the probability value represents the limiting frequency of an infinite population. The observed frequency does not determine the value of P, so any discrepancies between the observed and postulated frequencies occasions no problems for Armstrong as long as the observed population is not infinite.[1]

Van Fraassen's final argument develops further the problem of determining the probability value P. In an attempt to clarify his position, Armstrong declares that his probabilistic laws only encompass those particulars which instantiate the law, and not any chance occurrences that merely resemble the law: "The law gives a probability of Fs being Gs *as an instantiation of the* $F \rightarrow G$ law. It is not directly concerned with the proportion of Fs that are G. . ." (1988a, p. 227). Van Fraassen protests this line of reasoning, insisting that "we have relegated $(N{:}P)(F{:}G)$ to a purely explanatory role (1989, p. 115). In short, the very purpose of the probability value P has now been subverted, since it has little, if any, relation to observed instances of Fs being Gs on Armstrong's account. In fact, one cannot even predict the probability of an F being a G given this theory. The only purpose of Armstrong's probabilistic law, on van Fraassen's estimation, is to now *explain* those instances of Fs that are Gs due to the universal $(N{:}P)(F{:}G)$; but, since there are chance occurrences of Fs being Gs, we cannot even be certain which of the observed FG occurrences are real instantiations of the FG law.

Although van Fraassen's argument is quite convincing, it is hard to see how it can make any impression on Armstrong given his overall project. Van Fraassen, the scientifically-inclined empiricist, is concerned with providing an account of probabilistic laws that accurately reflects their use in the sciences: hence, the probability values invoked in a philosophical theory should closely resemble the values manifest in actual scientific practice. Armstrong, on the other hand, the ontology-centered metaphysician, is motivated by a desire to solve the induction problem (i.e., differentiating natural laws from mere regularities). If a philosophical account of natural laws resolves the induction problem, but in the process generates some strange empirical consequences at odds with actual scientific practice, then that is simply the metaphysical price that will have to be paid for a consistent theory of scientific properties. Armstrong's response to these sorts of difficulties, or options, is rather telling: "How can we tell which cases of the FGs are which? 'That is an epistemic matter' we realists reply. Perhaps one would not be able to tell" (1988a, p. 227). Given this kind of philosophical direction and purpose, van Fraassen's criticisms are inevitably rendered ineffective, if not irrelevant.

2. Towards a New Strategy of Critiquing a Universals Theory

Despite van Fraassen's good intentions, it thus appears that Armstrong can side-step many of the difficulties raised for his probabilistic laws either by invoking subtle changes in his existing theories (the "infinite particulars" hypothesis), or by dismissing the problems as irrelevant given the intended goal of his overall project (the epistemically inaccessible probability value). Van Fraassen's arguments have gone awry, it would seem, because they have been directed at the working-out of the specific details of Armstrong's theory. More precisely, he has tried to undermine Armstrong's universals theory of probabilistic natural laws by demonstrating that it embodies empirical inconsistencies or basic deficiencies that render it unsuitable as a foundation for natural laws.[2] Yet, as we have seen, if one grants that Armstrong's theory resolves the induction problem, then any difficulties raised by "skirmishing along the border" will be easily dismissed by Armstrong as insignificant (unless the defects are major, which van Fraassen's apparently are not). Consequently, the critic may find it more advantageous to explore the complex concept of a physical "property" in an effort to undermine Armstrong's claim that a universals theory is a successful means of separating mere regularities from the necessary connections among particulars. In what follows below, we shall review a possible strategy of accomplishing this task.

Given the vast array of potential physical properties, one of the dilemmas a universals theory of natural laws must face is the actual selection of the universals that will figure in its laws. In many cases, the usefulness of a physical property for natural law service will depend upon its location and participation in particular physical systems. Besides the well-known examples cited in the philosophical literature, such as ascribing the property of "portability" to skyscrapers, there are more sophisticated examples from the history of science. For instance, Christiaan Huygens demonstrated that Descartes' generally incorrect conservation law for the "quantity of motion" (size times speed) could be salvaged if all collisions were viewed from the colliding bodies' center-of-mass perspective (As viewed from this reference-frame, which can be reached by a simple Galilean transformation, the ratio of their speeds is reciprocal to the ratio of their sizes, thereby allowing the bodies to preserve their initial speeds after rebound according to Descartes' first collision rule.[3]) Thus, "quantity of motion" would seem as legitimate a candidate for universals treatment as momentum or energy.[4] As Mark Wilson has commented in his investigation of the vibrational "modes" of metal plates discovered by E. Chlandi (and later developed by Fourier): "since the specific set of relevant properties [for describing behavior] tends to vary from system to system, Chlandi's discovery and its aftermath forces physics to become generous in its allotment of properties" (Wilson 1993, p. 67). So, one might reasonably conclude that a universals theory will have to take account of these additional properties if it desires to take an accurate inventory of the complete stock of universals. Unfortunately, an inexhaustible supply of such properties can be easily obtained—and asserted to hold for *all* systems—by merely examining an array of different (and peculiar) phenomena, such as the collisions of bodies in a center-of-mass reference frame. As a direct result, the ontology of universals, as well as the number of their contingent relationships, will quickly reach infinite proportions.

More importantly, since Armstrong regards the contingent relationships among universals as generating the necessary connections in the world, the number of necessary relationships among physical bodies will likewise mount at an alarming rate. This raises new obstacles for the universals theory, however, since these necessary relations were supposed to separate the natural laws from the accidental generalizations (such as, "all the coins in my pocket are silver"). That is, necessary connections among particulars are due to natural laws, while mere accidental relationships among properties are not. Nevertheless, given the possibility that a limitless number of "useless" properties (like quantity of motion) can be ascribed to most physical systems, an endless supply of equally useless laws of nature (such as the conservation law for quantity of motion) will be created that play little or no role in explaining the behavior of the vast majority of physical systems. Therefore, a *new form of the induction problem is raised;* namely, which of the many natural laws are the "real", or useful, natural laws? Or, if Armstrong denies the claim that just any relation between universals qualifies as a law of nature, as he clearly must, then he will acquire the unsavory task of explaining why certain relations do, and others do not, amount to natural laws.

In order to salvage the universals theory from this criticism, it would seem that Armstrong will inevitably have to claim that only those contingent relations among universals useful in explicating the behavior of physical objects should qualify as actual laws of nature. Armstrong, in fact, utilizes inference to the best explanation to justify the choice of natural laws (see, 1983, p. 59)—yet, such a response seems to invalidate the underlying methodology of the universalist theory, since "inference to the best explanation" (IBE) relies upon experience of physical processes to determine which of the various competing explanations best accounts for those empirical observations. Consequently, rather than introduce natural laws (relations among universals) to explain the "necessary" behavior of physical objects, the behavior of physical objects is being used to explain which universals (i.e., properties) are necessary for the natural laws. More precisely, how can a universals theorist consistently put forward the view that (i) it is the necessary relations among universals that *explain* the necessity among particular objects, while (ii) additionally requiring that these necessary relationships are entirely dependent upon our best *empirical* judgment of the *regularities* among bodily properties. Accordingly, if our best guess as to the relationships among properties, based on empirical observations in conjunction with IBE, leads us to conclude that "if x is solid gold, then x weighs less than 10,000 lbs.", then it would seem to follow that this constant conjunction of bodily properties should qualify as a genuine law of nature. Armstrong cannot invoke the necessity among universals to dismiss this proposed natural law, moreover, since the very formulation of his universals theory is dependent upon experience of the regular conjunction of properties. Consequently, an appeal to "inference to the best explanation" cannot help Armstrong in resolving our "new" induction problem since all such inferences are based on the best assessment of our current empirical data (as above). In contrast to van Fraassen's inconclusive criticisms, a more powerful and persuasive reason has thus been uncovered for rejecting the universals theory—in short, the universals theory fails to achieve one of its most touted philosophical objectives, namely the separation of accidental regularities from real natural laws.

The "context" dependence of physical properties thus demonstrates that, among other things, the view of science which Armstrong would have us accept—of a "neat and tidy" conjunction of basic properties that explains the behavior of objects—does not hold up to closer inspection. The properties that are important to describing the behavior of objects is quite variable and allows many alternatives (depending on such factors as the beliefs and motivations of the scientists, nature of technical and mathematical apparatus, etc.). Of course, these well-known facts do not entail that a universals project cannot account for this variability of scientific practice, but it does seem to suggest that the universalists are attacking the problem of natural laws from the wrong direction. As mentioned, a more profitable explanation might state that it is the interactions and behavior of physical objects (in particular systems) which generate and dictate the properties useful for explaining the phenomenon (via laws of nature). A "bottom-up" approach, from the particular objects in physical systems to properties, rather than Armstrong's "top-down" analysis from properties to objects, also seems to successfully answer van Fraassen's appeal for a theory of natural laws faithful to scientific practice. Overall, this position does not deny that properties exist and are important in science: it only denies that one can devise an "absolute" network, or "one true view", of the ontology of physical properties.[5]

Although the problems raised in this section do not exhaust the available methods of critiquing a universals account of natural laws, the primary intent has been to point out the most suitable target for an anti-universals theorist. The rallying point for the critic of a universals theory should be (at least in part) the assumption that such accounts both resolve the problem of induction and provide a philosophically palatable treatment of the concept of a physical property. The critics have usually not devoted sufficient attention to the former; yet, as we have seen, this may prove to be the one of the most effective weapons at their disposal.

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NOTES

1 Van Fraassen demonstrates that the discrepancy in observed and postulated probabilities arises for all finite cases, and not just for a world with one instantiation. Nevertheless, Armstrong's maneuver clearly meets this challenge, as well. It should also be noted that these arguments against Armstrong were first raised by van Fraassen (1987).

2 We have only examined van Fraassen's critique of Armstrong's probabilistic laws, but the same problems would seem to arise for most of his arguments against other types of natural laws and other universals theorists: e.g., the "Lawgiver's Regress" which he aims at F. Dretske and M. Tooley, in addition to Armstrong (roughly, that a universals explanation of a natural law leads to a vicious infinite regress of higher-order laws; van Fraassen (1989), pp. 99-109). This regress can apparently be blocked by merely stipulating that universals do not have the capacity to form them. This response is clearly ad hoc, but if we are willing to allow the ontological extravagance of universals into our world view (which is a mysterious entity in every sense of the term), then why not go a step further and admit non-regress forming universals!

3 For a discussion of the details and philosophical ramifications of Huygens' approach to mechanics, see, Westfall (1971), chap. 4.

4 In all fairness, it is not clear what role Armstrong provides these properties. They may count as functional properties falling within the scope of functional laws (see, Armstrong (1983), chap. 7).

5 Hilary Putnam, for instance, has long argued against this form of realism (which he dubs "metaphysical realism"), and is apparently the realism presupposed in Armstrong's universals theory (see, for example, Putnam (1995), chap. 14 & 15). Also, the view put forth here concerning natural laws is similar to Putnam's view of the ordinary language conception of causation, where the aspects of a system that are to count as the "cause", and those that are to count as the "background conditions", are not invariant across all scientific uses and perspectives. Rather, the exact nature of the causal properties and explanations depend on the interests and goals of the observer: e.g., "The absence of holes in the vessel of the pressure cooker was the cause of the explosion" (see, for example, Putnam (1992), chap. 3).

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Abstract

This paper contends that some of the recent critical appraisals of universals theories of natural laws, namely, van Fraassen's analysis of Armstrong's probabilistic laws, are largely ineffective since they fail to disclose the incompatibility of universals and any realistic natural law setting. Rather, a more profitable line of criticism is developed that contests the universalists' claim to have resolved the induction problem (i.e., the separation of natural laws from mere accidental regularities), and thereby reveals the universals' philosophically inadequate concept of a physical property.