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HYPOTHESIS AND EXPLANATION IN KANT'S PHILOSOPHY OF SCIENCE*

by ROBERT E. BUTTS

I. Introduction

Kant's substantive contributions to the epistemology of science—his analysis of categories in terms of rules, his recognition of the inadequacy of empirical attempts at a justification of induction, to name only two — are fairly well recognized today; and the frequency with which his views are cited (both correctly and incorrectly) bears sufficient testimony to the lasting value of his work in the philosophy of science. However, certain aspects of Kant's philosophy of science are not so well known nor their importance recognized. For example, the formal considerations on methodology contained in the "Transcendental Doctrine of Method" in the *Critique of Pure Reason* are, except for the celebrated distinction drawn between philosophy and mathematics, largely unexplored. Perhaps this is in part because Kant's major commentators have found the task of getting beyond the "Analytic" of the first *Critique* too great and also in part because the formal analysis of methodological problems has so rapidly gone beyond the Kantian historical frame of reference.

Nevertheless, to ignore Part II of the first *Critique* is to miss some of Kant's finest philosophic moments. It has always been admitted that the "Doctrine of Method" provides a kind of bridge between knowledge and belief and thus functions as a preface to the later *Critiques*. In addition, some of Kant's thought in this section shows how fully absorbed he was in the atmosphere created by several prevailing attitudes, like the desire (found in Hume and Reid, among others) to keep creative imagination (as in art) and philosophical analysis and natural science) distinct. Finally, there are suggestions in the "Doctrine of Method" which, when reformulated in more contemporary language,

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enable us to see a little more clearly the relation between physics and philosophy or more generally between the sciences and philosophy.

In what follows I shall endeavor to make these claims clear and justified by means of an analysis of Kant's conception of the role of explanatory hypotheses in science. At points in this analysis, I shall draw some parallels between Kant's thought on hypotheses and that of others in the Eighteenth Century. Also, since some aspects of Kant's thought stand out more clearly through confrontation with recent extensions or interpretations of his views, I shall make references to contemporary "Kantians" to illuminate certain points in the discussion.

II. Programmatic Principles in Science

Kant's views on the nature and adequacy of hypotheses are mainly contained in Chapter I, Section 3 ("The Discipline of Pure Reason in Regard to Hypotheses") and in Chapter II, Section 3 ("Opining, Knowing and Believing") of the "Transcendental Doctrine of Method"[1]. In the chapter on "Discipline"[2] Kant is discussing what some regard as methodology proper, and it is against this background that I wish to discuss his views on hypotheses.

Kant reminds us that when we are concerned with the formal conditions of a system of pure reason we need not criticism but *discipline*. We need to erect "a system of precautions and self-examination"[3] because we have to deal in the case of systems of pure reason with "a whole system of illusions and fallacies"[4]. In his meaning of "discipline", Kant is explicit: "The compulsion, by which the constant tendency to disobey certain rules is restrained and finally extirpated, we entitle *discipline*"[5]. It is, of course, the metaphysical "tendency" that Kant is here concerned to discipline. We know at the outset of this discussion that his analysis of method will endeavor to accomplish two things. He will try to show the rules by means of which the philosopher (the natural scientist) must proceed if he wishes to produce positive knowledge of experience,

[1] Immanuel Kant, *Critique of Pure Reason*, [1781, 1787], A 769—782, B 797—810; A 820—830, B 848—858, Norman Kemp Smith translation, London 1950.

[2] *Ibid.*, A 709—794, B 737—822.

[3] *Ibid.*, A 711, B 739.

[4] *Ibid.*

[5] *Ibid.*, A 709, B 737.

and he will endeavor properly to distinguish science from metaphysics, to solve what Popper has called the "demarcation problem"[6].

Of course for Kant the demarcation problem was already solved in Part I of the first *Critique*, and its solution is brought to bear on the question of what constitutes an adequate hypothesis. In fact, as the opening sentence in the section on "Pure Reason in Regard to Hypotheses" shows, it is precisely his solution of the demarcation problem — a solution that sharply contrasts positive scientific knowledge and speculative metaphysics — that makes it imperative for Kant to consider the question of criteria for adequate hypotheses. He writes:

> Since criticism of our reason has at last taught us that we cannot by means of its pure and speculative employment arrive at any knowledge whatever, may it not seem that a proportionately wider field is opened for *hypotheses*? For are we not at liberty, where we cannot make assertions, at least to invent theories and to have opinions[7]?

Kant's answer to both questions is "no" and the argument that follows this passage is designed to exhibit the conditions under which alone hypotheses may legitimately be entertained. Hypotheses, on Kant's view, are creations of the imagination, in a non-technical sense of "imagination" unlike the various precise senses of the word found in the "Analytic"[8]. Kant also uses the word "hypothesis" in several places as synonymous with "opinion." Both identifications appear unfortunate to a twentieth-century reader, for to identify "hypothesizing" with "imagining" suggests that hypotheses are *only* fictions, and to identify "hypothesizing" with "opining" makes it appear that hypotheses are purely subjective feelings. The second identification may seem even more paradoxical when we consider Kant's explicit definition of "opining." "*Opining* is such holding of a judgment as is consciously insufficient, not only objectively, but also subjectively"[9]. What is here implied is that hypotheses in their scientific employment will never be more than *consciously* recognized fictions. This conclusion is only a half-step removed from the shallow positivism sometimes associated (mistakenly) with Newton's celebrated "*hypotheses non fingo.*"

The key to unravelling the puzzle (if one agrees that it is puzzling to be driven into regarding Kant as a kind of positivist) is provided by

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[6] KARL POPPER, *The Logic of Scientific Discovery*, New York 1959, 34, 311.

[7] KANT, *Op. cit.*, A 769, B 797.

[8] *Ibid.*, A 102, A 118—119.

[9] *Ibid.*, A 822, B 850.

recognizing that in a very crucial sense Kant accepts the Newtonian dictum, since his distinction between reliable knowledge and metaphysics (it is after all the metaphysical "tendency" to disobey sound methodological rules that is to be "disciplined"), if correct, warrants the claim that genuine knowledge possesses both universality and necessity. And surely these are not characteristics of opinions or hypotheses. So regarded, Kant's discussion of hypotheses in the section in the "Doctrine of Method" may be seen as both a defense and a reinforcement of Newton's methodological postulate. But this is true — and this is the capital point — only where the problem is one of keeping metaphysics out of science. Grant Kant that this divorce is necessary, and he is willing to concede that there are three legitimate senses in which one may utilize hypotheses, two related to the question of employment of hypotheses in science, one related to the usefulness of hypotheses in philosophical polemics.

Leaving out of account here Kant's discussion of the polemical use of transcendental hypotheses (metaphysical ideas in no way based upon experience) and the practical use of metaphysical ideas, as in religion and ethics, the two senses in which hypotheses may be thought of as permissible in science warrant full attention.

Hypotheses in science have for Kant either an explanatory or a programmatic (regulative) use. We remember from earlier discussion in the first *Critique*[10] that any concept of pure reason, though no object met with in actual experience is ever subsumed under it, may function in thinking as a heuristic principle giving order and coherence to scientific systems and perhaps suggesting new avenues of empirical research. It is thus quite admissible to *think*, say, that the soul is simple, and thus to interpret mental activity as based essentially upon an inherent unity of psychic faculties, but we can never *know* this to be so. Furthermore, in Kant's view we can never legitimately *assume* it as an *explanatory* hypothesis because concepts of reason, even in their regulative employment, fail to satisfy the categorial conditions making knowledge possible.

Another way of putting this point with respect to the programmatic employment of hypotheses (e. g., the simplicity of the soul) is exhibited by Kant in his famous assertion that in science — in

[10] *Ibid.*, "The Regulative Employment of the Ideas of Pure Reason", A 642, B 670.

this case psychology — we will proceed *as if* mental behavior was connected in a self-identical simple mental substance[11]. I do not think, however, though one may surely put Kant's point in this way, that what is here involved is Vaihinger's famous Fictionalism. Kant's thinking here more closely corresponds to that of certain contemporary philosophers, Margenau[12] and Körner[13] for example, who think of metaphysical ideas in their regulative employment as providing programmatic contexts in which mathematical scientific theories of a certain type are to be constructed. An example will perhaps make this clear.

In their 1935 paper on quantum mechanics Einstein, Podolsky and Rosen proposed the following criterion of "physical reality".

> If, without in any way disturbing a system, we can predict with certainty (i. e., with probability equal to unity) the value of a physical quantity, then there exists an element of physical reality corresponding to this physical quantity[14].

On the basis of this criterion the authors reject the explanatory formalism provided by quantum mechanics as inadequate. This rejection does not mean that Einstein and the others "knew" (as a matter of scientific discovery) that physical realities are those whose existence is guaranteed by the fact that deterministic laws can be written for describing their behavior. All it means is that a certain regulative — essentially normative — principle was at work in their thinking about quantum descriptions. The reality criterion amounts to what Margenau calls a "metaphysical requirement"[15] of physical constructs: it is a principle which all physical systems must satisfy in order to be acceptable to the named authors. Körner puts the point even more neatly: these metaphysical propositions ". . . function as regulative principles governing more or less strictly the search for physical formalisms and the choice between them"[16].

Kant must be regarded as having come upon a genuinely helpful way of conceiving the relationship between metaphysical ideas and

[11] *Ibid.*, A 672, B 700.

[12] HENRY MARGENAU, *The Nature of Physical Reality*, New York 1950.

[13] STEPHAN KÖRNER, *On Philosophical Arguments in Physics*, in *The Structure of Scientific Thought*, ed. E. MADDEN, Boston 1960, 106. Cf. KÖRNER, *Kant* (Pelican Books), 1955, 103—104.

[14] A. EINSTEIN, B. PODOLSKY and N. ROSEN, *Can Quantum Mechanical Description of Physical Reality Be Considered Complete?*, in *Physical Review* 47 (1935) 77.

[15] MARGENAU, *Op. cit.*, 75.

[16] KÖRNER, *On Philosophical Arguments in Physics*, 109—110. For a fuller discussion of what Körner there refers to as metaphysical "directives" see Chs. XXX—XXXIII in his *Conceptual Thinking*, New York 1959.

"constitutive" principles yielding knowledge. He seems to have been the first to recognize explicitly that to *think* nature in certain terms is not to *assume* that these terms count as a sound explanation of nature's behavior[17]. Put in contemporary analytic language, Kant recognized that the logical grammar of "to think" is not the same as that of "to assume." If we interpret Kant's view of regulative principles in light of the above suggestions, then his position comes down to saying that, for example, *to think* nature as determined (say in the Newtonian sense) is to decide that no explanation of nature in non-deterministic terms will be acceptable. It is *not* to say that success in explaining nature deterministically *confirms* that it is so. One can *confirm* (empirically) an explicit *assumption* because an assumption is either true or false. But a *thinking-of* nature as such-and-such is not either confirmable or disconfirmable. It is a program only, a decision to carry on science in one way rather than another. Kant therefore seems to have known that adopting a rule for playing a game of a certain kind is not the same as establishing a case by experimental or observational means.

III. The Role of Categories in Scientific Explanation

Kant thus thinks it legitimate to employ metaphysical propositions programmatically in constructing scientific systems and in carrying out research. His willingness to admit the importance of these regulative ideas is sufficient warrant for removing the implication of positivism which his remarks at places in the "Doctrine of Method" suggest. When Kant's discussion moves from regulative ideas to the use of hypotheses in science proper — the use of empirical guesses thought to be either true or false — he is quite explicit about the conditions that must be satisfied by any admissible scientific (empirical) hypothesis. What Kant must show is that, given his definition of "opinion" and his conviction that metaphysical propositions are *per se* mere personal convictions (mere creatures of the "visionary" imagination), scientific hypotheses are rendered legitimate with reference to the presuppositions making knowledge of experience possible. As we might expect, therefore, his theory of scientific hypotheses must be developed in a way showing their use to be wholly consistent with the results of the "Transcendental Analytic", which explicitly determine the limits of reliable scientific knowledge.

[17] KANT, *Op. cit.*, A 771—772; B 799—800.

The paragraph in which Kant indicates the first condition for an adequate hypothesis is worth quoting in full.

> If the imagination is not simply to be *visionary*, but is to be *inventive* under the strict surveillance of reason, there must always previously be something that is completely certain, and not invented or merely a matter of opinion, namely, the *possibility* of the object itself. Once that is established, it is then permissible to have recourse to opinion in regard to its actuality; but this opinion, if it is not to be groundless, must be brought into connection with what is actually given and so far certain, as serving to account for what is thus given. Then, and only then, can the supposition be entitled an *hypothesis*[18].

In this interesting paragraph several crucial points are in need of separate treatment in order to catch the full meaning of Kant's brief statement of the criterion.

First, it is important to understand why Kant thought it necessary to deal with hypotheses as functions of the *imagination*, a conception insisted upon by him throughout the "Doctrine of Method". Thus he writes: "Outside this field [the series of objects of experience], to form *opinions* is merely to play with thoughts"[19]. And again:

> I must never presume to *opine*, without *knowing at least something* by means of which the judgment, in itself merely problematic, secures connection with truth, a connection which, although not complete, is yet more than arbitrary fiction. Moreover, the law of such a connection must be certain. For if, in respect of this law also, I have nothing but opinion, it is all merely a play of the imagination, without the least relation to truth[20].

There is a substantive point in these references to imagination (in the sense of "fancying", "playing with ideas"), for Kant must show that warranted empirical hypotheses are more than mere fictions, and he must also show that the *only* warranted hypotheses are *empirical*. His debt to eighteenth-century Newtonianism and to the British empirical tradition generally is here in evidence. This is precisely the tradition that had established it as a dogma that scientific thought or "philosophical talent" was incompatible with creative imagination, with the necessary corollary that speculative system-building and scientific work are fully distinct. The precedents for this context of thought in the Eighteenth Century are so plentiful that it seems unreasonable not to regard Kant as heir to this tradition. Indeed, the positive use to which he puts one form of the distinction in the *Critique of Judgment* provides additional strong evidence of Kant's heavy reliance on the dogma[21].

[18] *Ibid.*, A 769—770, B 797—798.

[19] *Ibid.*, A 775, B 803.

[20] *Ibid.*, A 822, B 850.

[21] Immanuel Kant, *Critique of Judgment*, trans. J. Bernard, New York 1951, 10—17. Here Kant distinguishes between synthetic *a priori* principles as rules of

Perhaps the distinction between what Kant calls "inventive imagination" and "visionary imagination" begins with Newton's critique of the speculative excesses of Cartesian physics. Surely it is to be found abundantly stressed in both the French and British lines leading out of Newtonianism. In France, Condillac's distinction between speculative, hypothetico-deductive and inductive systems of science in his *Traité des systèmes* implicitly accepted the distinction. Elsewhere I have shown that d'Alembert was the chief French spokesman for the distinction[22]. In the "Discours préliminaire" he wrote: "The taste for systems, a taste more appropriate for flattering the imagination than for enlightening the reason, is today almost completely banished from sound treatises"[23].

In the British tradition, Hume is busy in both *Treatise* and *Inquiry* distinguishing "serious conviction" from "poetical enthusiasm," correct judgment from imagination[24]. The *Treatise* even gives evidence that Hume regarded the creative imagination as a sort of pathological state (shades of Plato?): ". . . a lively imagination very often degenerates into madness or folly"[25]. In the same vein, Thomas Reid insists on the separation of poetry and philosophy (traditional metaphysics being identified with poetry), imagination and conception. His famous statement in the *Inquiry* is a fair summary of eighteenth-century thought on this matter.

> It is genius, and not the want of it, that adulterates philosophy, and fills it with error and false theory. A creative imagination disdains the mean offices of digging for a foundation, of removing rubbish, and carrying materials; leaving these servile employments to the drudges in science, it plans a design, and raises a fabric. [But] . . . happily for the present age, the castle-builders employ themselves more in romance than in philosophy. That is undoubtedly their province, and in those regions the offspring of fancy is legitimate, but in philosophy it is all spurious[26].

I am not suggesting that Kant was familiar with the details of this eighteenth-century climate of opinion; I am however prepared

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understanding and judgments of freedom as rules of *understandability*. The non-categorial use of judgments of freedom accounts for the possibility of artistic creation or more generally for the possibility of culture as distinct from nature.

[22] *Rationalism in Modern Science: D'Alembert and the Esprit Simpliste*, in *Bucknell Review* VIII, 2 (1959).

[23] JEAN LE ROND D'ALEMBERT, *Oeuvres Complètes*, Paris 1821—22, I, 31.

[24] DAVID HUME, *An Inquiry Concerning Human Understanding*, [1748], ed. CHARLES HENDEL, New York 1955, 170; and *A Treatise of Human Nature*, [1739], ed. L. A. SELBY-BIGGE, Oxford 1951, 123, 267, 630—632.

[25] HUME, *Treatise*, 123, 630—632.

[26] THOMAS REID, *Inquiry Into the Human Mind*, [1764], in *The Works of Thomas Reid*, ed. W. HAMILTON, 7th ed., Edinburgh, 1822, I, 99.

to insist that Kant's own advocacy of the difference between science as reliable knowledge and metaphysics as visionary play of the imagination bears evident testimony to his having a rightful place in the two traditions indicated. There is much more to the story than I have here related[27], but it appears true that the history of classical modern philosophy — so far as it tends to culminate in Kant — might be read more correctly (certainly more interestingly) if Kant's philosophy were regarded not only as a synthesis of rationalism and empiricism, but also as the final constructive making of the distinction here being discussed. At the very least these remarks on the context of Kant's thought bear witness to one other important respect in which the first *Critique* is a vindication of Newtonianism.

The next major aspect of Kant's statement of the first criterion for an adequate hypothesis — this in part follows from his distinction between "visionary" and "inventive" imagination — is his view that a proper scientific hypothesis must be grounded on some reliable basis. As he puts it, we are not entitled to have opinions about the course of nature until we "know at least something by means of which the judgment . . . secures connection with truth," until we establish something certain, namely, "the possibility of the object itself". Finally, the hypothesis must "account for" what is given, that is, must *explain* some phenomenon.

What Kant has in mind here is related to the positive case he makes out for the "possibility of experience" in Part I of the *Critique*. Since Kant himself often illustrated his views by means of the example of causality, it will be well to limit ourselves here to discussing so-called *causal* hypotheses. The question now becomes: when are we entitled to hypothesize causes or propose causal explanations? Kant's answer would be that we must first of all experience series of objects arranged in causal sequence. But this is never a wholly empirical matter. For Kant the guarantee that certain objects of experience are causally ordered is obtained from

[27] For example, there is evidence in some of Kant's pre-critical works that he had come to identify the speculative excesses of metaphysics with imaginative castle-building. As early as 1755 in *Allgemeine Naturgeschichte und Theorie des Himmels* he begins to reject the notion that ideas are only acceptable when incorporated into comprehensive rationalistic systems, and in 1766 in *Träume eines Geistersehers erläutert durch Träume der Metaphysik* he specifically identifies certain types of spiritualistic metaphysics with fanciful dream castles. Much work still remains to be done on Kant's pre-critical attitudes towards both science and philosophy.

the category of causality and from the synthetic *a priori* principle — functioning as a rule — that every event has a cause.

It must be recalled that for Kant the "possibility" of objects of experience is established (in the "Analytic") by the complicated attempt to show that no knowledge of sense experience is possible without a set of synthetic *a priori* principles ordering and interpreting mere sensuous intuitions. To hold, then, that no hypothesis is admissible that is not "connected with the given" by means of a law which is certain and is not based on the possibility of the object it is introduced to explain, is to hold that no hypothesis about nature is justified unless it is compatible with a category and its attendant rule of the understanding. Thus causal hypotheses are legitimate in science because the possibility of experiencing objects in causal sequence is provided for by the category of causality, and the law connecting the hypothesis with objects of experience — the synthetic *a priori* rule "every event has a cause" — is for Kant certain because it is both *universal* (applying to all "possible" experience) and *necessary* (it cannot be denied without contradicting the very possibility of having knowledge-yielding experiences).

It must I think be remarked that in general Kant was quite right in insisting that scientific hypotheses fulfill the requirement that propositions offered in explanation of sensory experience be connected with possible objects of experience by laws of connection that are themselves certain, even though the details of this contention are not free from dispute. He was after all dealing with the question of the legitimacy of *explanatory* hypotheses. Kant did not think of explanation in terms of the deductive model, and this is one of the reasons why he nowhere offers the so-called "predictability criterion" of adequacy for hypotheses[28]. How are we, then, to justify the introduction of a hypothesis if its predictive power is not to be taken as the key index of its explanatory force? Kant's problem is really the problem of *relevance*: when is the proposed

[28] See the classic paper by CARL HEMPEL and PAUL OPPENHEIM, *The Logic of Explanation*, in *Readings in the Philosophy of Science*, ed. E. FEIGL and M. BRODBECK, New York 1953, 319. Recent discussion of the nature of explanation tends to react unfavorably to this deductive model and to stress something like Kant's view of explanation as increase of understanding. See, e. g., I. SCHEFFLER, *Explanation, Prediction and Abstraction*, in *British Journal for the Philosophy of Science* 7 (1957) 293; N. RESCHER, *On Explanation and Prediction*, *ibid.* 8 (1958) 281; J. YOLTON, *Explanation*, *ibid.* 9 (1959) 194; and N. R. HANSON, *Patterns of Discovery*, Cambridge 1958.

hypothesis relevant to the occurrences it is supposed to explain? Furthermore, since the question of relevance is construed byKant in terms of significance, or better *intelligibility*, rather than in terms of the predictive power of an explanation, what he needs is a criterion for the adequacy of a hypothesis that separates explanations that make events intelligible from those that do not.

To give an explanation in the sense of rendering an event intelligible, rather than in the sense of offering a hypothesis with strong predictive force, is a matter of reducing the unexplained event to an acceptable explanatory basis. Of course the basis must itself not stand in any need of explanation (in Kant's term, must not be merely another "opinion") or else an explanation has surely not been given. The methodological implication of an infinite regression of explanatory bases was unacceptable to Kant and has been to all methodologists. Now it may be that one person's conception of an acceptable explanatory basis differs from that of another only on the grounds of what Professor Goodman has recently called the "philosophic conscience"[29] of that individual. It would certainly seem to be the case that the question of justifying the basis of all justification or explaining the basis of all explanation is a kind of contradiction in terms. One must accept *something* without explanation, an admission that seems to be as old as Aristotle. Thus whether we go along with Kant and regard the basis of explanation as certain, or construe the explanatory basis as a program for the construction of theories of a certain type, or pass the whole matter off as a simple question of "philosophic conscience" is really irrelevant. Just as clarification can only be attained on the basis of that which is taken as clear without being itself in need of further clarification, so explanation can only be given on the basis of that which is taken as justified without being itself in need of explanation.

Kant's own decision on the matter of an acceptable basis for scientific explanations is clearly stated:

> In the explanation of given appearances, no things or grounds of explanation can be adduced other than those which have been found to stand in connection with given appearances in accordance with the already known laws of the appearances[30].

Kant always insists that categories can only be properly used in application to experience. It is thus categorized experience itself that determines the relevance of a hypothesis. We can only hypothesize explanations when these are consistent with empirical laws

[29] Nelson Goodman, *Fact, Fiction, and Forecast*, Cambridge (Mass.) 1955, 37.
[30] Kant, *Critique of Pure Reason*, A 772, B 800.

already established by experience. The laws themselves in turn depend upon subsumption of the events they describe under categories by means of *a priori* rules. On this point Kant is again unequivocal.

> Opinions and probable judgments as to what belongs to things can be propounded only in explanation of what is actually given, or as consequences that follow in accordance with empirical laws from what underlies the actually given. They are therefore concerned only with the series of the objects of experience. Outside this field, to form *opinions* is merely to play with thoughts. For we should then have to presuppose yet another opinion — the opinion that we may perhaps arrive at the truth by a road that is uncertain[31].

The results of Kant's discussion thus far now ought to be clear. Because reliable knowledge is always knowledge of experience, an adequate explanatory hypothesis needs to account *only* for the given experience. A hypothesis can so account for the given experience only if it is based on what is already known about experience and formulated in well-established empirical laws. Finally, since empirical laws are only possible on the basis of certain categorized experiences in compliance with synthetic *a priori* principles of the understanding, these principles and the categories they apply are the final explanatory basis of any hypothesis attempting to render intelligible some item of actual experience. Any explanation seeking to go beyond given experience *must* on this view amount to mere castle-building because for Kant the possibility of an object of experience can only be established by those principles which in turn render true and intelligible *only* experience. The circularity of this criterion is obvious, and is the same circularity to be noted in Kant's "transcendental deduction" of the categories[32]. Here as elsewhere the certainty of Kant's explanatory basis is analytic. The justification of the categories is ultimately that experience is impossible without them, and the justification of the possibility of knowledge-yielding experience is that such experience is categorized in just certain ways. In the tight architectonic of Kant's system it is logically inevitable that his account of the adequacy of a hypothesis should share the circularity of his initial justification of the categories in the "Analytic."

IV. A Priori and Deductive Explanations

I turn now to what Kant calls the "second requirement for the admissibility of an hypothesis," though I think it can be shown

[31] *Ibid.*, A 775, B 803.

[32] See KÖRNER, *Kant*, 68—69.

that it is not a separate criterion, but only an extension of the first. Kant says that a hypothesis must account adequately "*a priori* for those consequences which are [*de facto*] given"[33]. He has already determined the sense in which an explanatory hypothesis must be able to account *a priori* for the data it is intended to make intelligible. Normally when we think of ways of accounting for facts *a priori* we either conclude with Hume that any such attempt is doomed to failure or we think (after the fashion of the widely discussed deductive model of explanation) that the only way in which we can account *a priori* for given experiences is by showing that a statement describing these experiences is logically implied by some law. Hume's way, of course, limits science to description, and we are then hardly entitled to talk about explanations at all. It is clear also that Kant would not accept the deductive model for explicating explanations.

I have already shown that Kant does not explicate the notion of explanation in deductive terms because he does not require predictive power of a hypothesis. Furthermore, on the deductive model of explanation, an event is explained if it could have been predicted on the basis of a known law, which is to say if a statement describing it is logically implied by that law. This account makes the law, or some deductively derivable implication of the law, the explanatory hypothesis. On Kant's view, however, phenomena are not explained by being shown to be deductive consequences of laws *only*; they are explained when the connection between the hypothesis and the phenomena is *certain*, that is, provides an acceptable explanatory basis. As argued above, this makes the principles of the understanding and their associated categories the ultimate bases of explanation.

Quite generally, then, we can account *a priori* for a given experience only if the connection between the judgment (in this case a hypothesis or opinion) and the experience is given, that is, if the law connecting the judgment and the object is certain[34]. Thus, for example, we are entitled on Kant's theory to make guesses about the causes of an event because of the certainty — the universality and necessity — of the causal principle. If we have a rule for connecting events of type X with events of type Y (the rule of under-

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[33] KANT, *Op. cit.*, A 774, B 802.

[34] *Ibid.*, B 166. "... *There can be no* a priori *knowledge except of objects of possible experience*". (Kant's italics.)

standing associated with the category of causality) we may, on appearance of Y_1, hypothesize X_1 as its cause. The guess may be wrong, but in Kant's theory we are entitled to make it, since *a priori* we can account for Y_1 by means of X_1. We can so account for Y_1 by means of X_1 only because the causal principle guarantees that every event has a cause.

For Kant it is mistaken to say that "X_1 is the cause of Y_1" is an explanatory hypothesis merely in virtue of its being an empirical law (if indeed it is a law). The event Y_1 is "explained" by being brought into connection with X_1 by means of the causal principle, which principle subsumes the connected events under the category of causality. But it is not enough to think that since "X_1 is the cause of Y_1" is subsumed under, is an instance of, "every event has a cause", it is therefore a merely deductive consequence of this causal principle. "Categorial subsumption" is not the same as "logical subsumption". For to deny the statement "X_1 is the cause of Y_1" while accepting the statement "every event has a cause" is not to be involved in logical contradiction. Rather, such a denial would only amount to a decision not to think nature in causal terms, at least in this instance. We are of course free to do this if we wish, but Kant would say that such a denial rendered knowledge-yielding experience impossible[35].

Acceptance of logical contradictions makes all *thinking* impossible. However, on Kant's distinction between "thinking" and "knowing", we are justified in holding that we can *think* nature in any way we wish provided only that our thoughts are consistent with one another[36]. There is only one way in which we can *know* nature, and that is through subsumption of events under categories by means of rules of the understanding. The "necessity" associated with the synthetic *a priori* principles of the understanding is then somewhat broader in scope than that involved in the ordinary notion of "logical necessity".

Again we are driven to the recurring theme of Kant's entire discussion of hypotheses. A hypothesis may be regarded as legitimate only if its ultimate justification can be given in terms of the categories. In the above example, the statement "X_1 is the cause of Y_1" is a legitimate explanatory hypothesis only because the causal principle subsumes the connection between X_1 and Y_1 under the category of causality. For Kant this is the only sense in which we

[35] Cf. KÖRNER, *Op. cit.*, 25, for another treatment of this point.

[36] KANT, *Op. cit.*, B xxvi—xxviii, B 166—167, A 771, B 799.

may say that "X_1 is the cause of Y_1" explains Y_1, or makes Y_1 intelligible. "Categorial subsumption" provides object-statements with *meaning*; it does not link object-statements with empirical laws by way of predicting the object-statements on the basis of the laws. To render nature intelligible — and this means to give significant explanations of the course of nature — we must know before prediction the *form* our laws will take. Nature, for Kant, does not speak for itself in a ready-made grammar. The categories supply the grammatical (i. e., epistemological) form, experience supplies the detailed content. On the deductive model of explanation, predictability is the only intelligibility principle. Acceptance of such an explanatory basis is not wrong; for Kant, I think, it would simply provide too narrow a basis for the more comprehensive kind of understanding of nature which he thought science makes possible.

The discussion above shows, I think, that Kant's second criterion for an acceptable hypothesis is only an extension of the first, since the explication of the notion of "accounting *a priori* for an event" takes us directly back to the first (and I think Kant's sole) criterion. When Kant says, "The second requirement for the admissibility of an hypothesis is its adequacy in accounting *a priori* for those consequences which are [*de facto*] given", he means only to underscore points made above in this paper concerning the acceptability of an explanatory basis. For Kant follows the sentence just quoted with the remark that if for the purpose of accounting *a priori* for an event "we have to call in auxiliary hypotheses, they give rise to the suspicion that they are mere fictions; for each of them requires the same justification as is necessary in the case of the fundamental hypothesis, and they are not, therefore, in a position to bear reliable testimony"[37]. Kant is urging the adoption of a methodological parsimony principle (which might be phrased, "hypotheses are not be to multiplied beyond necessity") which would keep a system of explanatory hypotheses both theoretically and practically manageable. If a system of auxiliary hypotheses were to become too numerous, the epistemological necessity of linking each hypothesis to its categorial basis might become exceedingly intricate and difficult, thus casting doubt on the explanatory power of the entire ensemble. Arguments based on this parsimony principle were brought against the (apparently) excessive number of hypothesized

[37] *Ibid.*, A 774, B 802.

epicycles and eccentrics in the astronomies of both Ptolemy and Copernicus, and against the multiplication of auxiliary hypotheses in the anti-vacuum theories of the Seventeenth Century. Kant may have had such arguments in mind in his introduction of this supposed "second requirement" for adequate hypotheses. It is clear, however, that Kant's first requirement must be met by *any* hypothesis which is to be regarded as adequate, and since auxiliary hypotheses constitute only a sub-set of the set of all possible hypotheses, the parsimony requirement is only an elaboration on his first (and only) adequacy requirement.

V. Conclusion

The fact that Kant's treatment of both regulative hypotheses and explanatory hypotheses follows consistently the lines drawn up in Part I of the first *Critique* should not give rise to the conclusion that his "Doctrine of Method" is after all only a dull repetition of points better developed earlier in this work. If my exposition and analysis of Kant's thinking on the methodology of hypotheses is correct, then I think we need to insist that the relevant sections of the "Doctrine of Method" (I do not mean to deny that other sections of this part of the *Critique* are valuable) teach two important lessons. First, we learn something important about the historical context of Kant's thought and begin to understand better the sense in which it is true to say of Kant's philosophy of science that it is a kind of final culmination of eighteenth-century thought. Second, in connection with his distinction between "visionary imagination" and "adequate hypothesis" and his positive doctrine of what counts as an adequate hypothesis in science we are given materials for reconstructing Kant's "categorial" philosophy of science in a way that retains its permanently valuable features and rejects its tone of absolute completeness and certainty.

It now appears that Kant's solution of the problem of marking off positive scientific knowledge from orthodox classical modern metaphysics must be located in the broad fabric of the eighteenth-century attitude that insisted on different, mutually exclusive employments of human imagination. One employment leads in the direction of the arts, and it is this employment also that accounts for the nature of some types of metaphysical thinking. The other employment of the imagination leads us to further knowledge of nature through the careful and disciplined use of hypotheses. In

Kant's distinction between the two employments of imagination reside the ghosts of earlier thought. Present is the spirit of Newton's criticism of the Cartesians and also the spirit of the *Philosophes'* similar quarrel with Cartesianism (though in the case of these French thinkers the attack on Descartes was paradoxically undertaken from a Cartesian standpoint[38]). But perhaps the most prominant ghost is the ghost of Hume's empirical spirit immortalized in the celebrated "bookburning" slogan in the last paragraph of the *Inquiry Concerning Human Understanding*[39]. However, on this point as on others, Kant has the last word: ". . . the wildest hypotheses, if only they are physical, are . . . more tolerable than a hyperphysical hypothesis, such as the appeal to a divine Anthor, assumed simply in order that we may have an explanation"[40]. The Eighteenth Century had begun to think of metaphysics as a *deus ex machina* hoisted on to the stage to save any scientific theory that appeared to have run out of explanatory power. The battle against the undisciplined employment of fictions in science had raged for some time prior to Kant, but it was the first *Critique* that insured philosophical victory.

The second great lesson of his teaching about hypotheses is connected with Kant's view of the nature of science as explanatory. The major point to recall is the distinction drawn above between "logical necessity" and "categorial necessity". Kant's synthetic *a priori* principles are rules subsuming sense-datum intuitions under categories. The principles are necessary only in the sense that to deny them — or to accept them while rejecting individual instances of their application — makes knowledge of experience impossible. Kant thought that such necessity, together with the fact that the principles and their associated categories are universal in their application, rendered the synthetic *a priori* principles certain. And though the basic insight — that nature yields knowledge only because ordered by rules not inductively derived from nature — is correct, few of us would continue in Kant's conceit of certainty.

The most promising line to take in any reconstruction of Kant's philosophy of science seems to me to involve a deliberate blurring of the distinction between the regulative and the (legitimate) explanatory use of hypotheses. We must agree with Kant that in the construction of scientific theories which are to render nature

[38] See my *Rationalism in Modern Science . . .*, 134—135.

[39] HUME, *Op. cit.*, 173.

[40] KANT, *Op. cit.*, A 773, B 801.

intelligible, synthetic *a priori* rules for such construction are indispensable. But such rules are always regulative in their employment. The moves made and countenanced in a given scientific theory are governed by certain norms or programs. We certainly do not achieve the kind of scientific theories we wish without such regulative principles or "metaphysical requirements", but, inasmuch as the principles are normative, they are, like all normative principles, never free from controversy and from possible change. In the kinds of scientific systems we now have, ordinary scientific hypotheses must still be brought into agreement with the programmatic principles governing the permissible moves to be made within a given system, and the use of hypotheses will still be intended to render nature intelligible — even in the deductive model of explanation, predictability is a concept of intelligibility — but the explanatory basis of these hypotheses will not, like Kant's synthetic *a priori* principles, be fixed and immutable, and will thus not establish the conditions of *all* possible experience. But whether we speak of "metaphysical requirements" as does Margenau, or of "metaphysical directives" as does Körner, or of the "pragmatic *a priori*" so well defended by Lewis[41], or of the rules of the scientific game (Popper's "methodological rules"[42]), we are still surely speaking Kant's language in its essential features. Any alternative to this much of Kant's transcendental idealism (e. g., positivism or inductivism) apparently falls short of providing a satisfactory epistemological explication of the nature of science.

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[41] C. I. Lewis, *Mind and the World-Order*, [1929], New York 1956; and *A Pragmatic Conception of the A Priori*, in *The Journal of Philosophy* 20 (1923).

[42] Popper, *Op. cit.*, 53—56.