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Some Extensions of Randall's Interpretation of Kant's Philosophy of Science

It has been just twenty years since I heard Randall's lectures on the history of philosophy at Columbia. I was a beginning graduate student without very much prior exposure to philosophy. Randall's lectures were a memorable experience, and as I have read the two volumes of *The Career of Philosophy*, I have enjoyed recognizing viewpoints, analyses, and even phrases that I first heard many years ago in the lectures. The wit, the literary quality, and the range of learning exhibited in these lectures were famous around Columbia long before the time of my own arrival. As a young scientist turned philosopher, the most important general thing I learned from Randall was not simply to read the great modern philosophers in terms of a close explication of text, but also to realize that they must be interpreted and considered against the background of the development of modern science. What he had to say in this connection about the British empiricists and about Kant was particularly important and significant.

In a work of the historical scope of *The Career of Philosophy*, it has been impossible to treat in detail many interesting aspects of the relation between the development of modern philosophy and science. What I would like to do in this article is to offer some extensions of Chapter 6 of Volume II, which deals with Kant's critical philosophy of science. The ideas that I want to discuss do not represent general differences with Randall, or with his interpretation of Kant, but constitute a detailed documentation of some of the main theses about Kant set forth by Randall in this chapter.

I have selected four topics that are central to many classical discussions in the philosophy of science. I shall focus especially on the philosophy of physics, which also provides an insight into how Kant attempted to work out the details of his philosophy of physics. For Kant's view of these details I shall depend particularly upon the *Metaphysische Anfangsgruende der Naturwissenschaft*.[1] This important work, in which Kant attempts to

work out a critical philosophy of physics, was published between the two editions of the *Critique of Pure Reason*. The relative neglect of this work in the large secondary literature on Kant in the nineteenth century can be explained only by the relative neglect of Kant as a philosopher of science. Randall's own emphasis on the intimate connection between Kant's philosophy and Newtonian physics is quite uncharacteristic of the nineteenth-century commentators.

The four topics I have selected are the relations between metaphysics and science, the application of the categories to mathematical physics, Kant's concepts of force and matter, and Kant's position on dynamical-versus-mechanical explanations of natural phenomena.

1. It is a familiar part of Kantian doctrine that the relatively great intellectual power of the mathematician comes from his monopoly of the objects given a priori in intuition. For the only pure forms of intuition are space and time, and only these forms can provide the a priori objects for the mathematical concepts of quantity and spatial figure. Corresponding to the many concepts with which the philosopher wants to deal, there are no a priori intuitions providing objects *in concreto*; constructions are thereby forbidden him and he is reduced to the mere analysis of concepts.

Actually, however, the philosopher is not quite reduced to mere empty analysis of a priori concepts. There are two other possibilities open to him, which constitute a division of the metaphysical portion of the pure, a priori part of a natural science.[2] The first possibility consists of transcendental and universal metaphysics. For this transcendental portion there are no determinate objects given a priori in intuition; transcendental metaphysics considers objects in general and thereby determines the conditions of all possible experience. The transcendental propositions of this metaphysic are not analytic, but a priori synthetic, for they provide the rules according to which we look empirically for the synthetical unity of (empirical) perceptions. This unity is required for experience itself to be possible. Although a priori synthetic, these propositions are philosophical rather than mathematical, for the mere laying down of rules governing the conditions of possible experience does not constitute construction of concepts: the conditions for the application of concepts to phenomena are determined, but not the actual construction of concepts.[3] The basic part of this transcendental metaphysic of nature is just what is developed in the Transcendental Aesthetic and the Transcendental Analytic of the *Critique*. The table of the categories provides a complete list of all the fundamental concepts which constitute pure knowledge, and the table of principles provides the rules for the objective application of the categories to phenomena, that is, empirical perceptions.[4] The *Critique*, however, does not provide a complete system of transcendental philosophy, for a

detailed analysis of the fundamental concepts and a complete list of the pure derivative concepts is omitted.[5] This lacuna was never filled by Kant.

What concerns us more here is the second possibility open to the philosopher. By taking an empirical concept from experience he may develop a particular metaphysic of nature, with the restriction that nothing may be borrowed from experience except what lies in this empirical concept.[6] In this case, since the object which generated the empirical concept is given in intuition, although only empirically, the philosopher can go beyond mere analysis of the concept and make synthetic assertions about it. Furthermore, these assertions may be a priori, although not pure in the strictest sense. The core of any particular metaphysic consists in the application of the concepts and principles of transcendental metaphysic, which were developed for objects in general, to the object, such as matter, given in empirical intuition. Corresponding to the two forms of sense, the external and the inner, are the concepts of two objects, which give us the two most important particular metaphysics. One takes as its basis the empirical concept of matter, and the other the empirical concept of a thinking entity (*denkend Wesen*).[7] Here it is the particular metaphysic of matter—corporeal nature—which concerns us.

This particular metaphysic, and the transcendental metaphysic as well, can aspire to a completeness which is impossible for either pure mathematics or general physics. The reason is that in a metaphysic, the object is considered only according to the universal laws of thought, whereas in mathematics and the sciences it is considered according to the data of intuition (pure or empirical), which are infinite in their multiplicity.[8] The metaphysical enterprise is to connect the object with all the necessary laws of thought, which are definite in number. As is to be expected, the table of the categories deduced in the *Critique* provides a fixed scheme for the completeness of such a metaphysical system; for as Kant maintains in the *Critique*, this table contains all the fundamental concepts which can be concerned with the nature of things.[9] This entails that all the a priori determinations of the concept of matter in general can be brought under the four classes of quantity, quality, relation, and modality. To carry the concept of matter through these four main divisions is then precisely the task of a metaphysic of corporeal nature.

A general comment on the respective roles of mathematics and philosophy in the foundations of natural science is in order. What exactly does each discipline contribute to natural science, and why is each necessary? I am not sure that I fully understand Kant's answer to these questions, but it seems to be the following. Metaphysics is essential to natural science because it provides laws or necessary principles dealing with the existence of a thing or object, such as matter. Mathematics cannot pro-

vide this portion; for the existence of something, in contrast to its possibility, can never be given in an a priori intuition.[10] I assume that an example of this is the law of conservation of matter, which in the particular metaphysic of matter follows immediately from the proposition of universal (transcendental) metaphysics that in the processes of nature no substance can either be created or destroyed.[11] Secondly, it generally seems to be the task of metaphysics to provide the a priori principles of construction used by mathematics.[12] For lack of a well-grounded metaphysic, mathematicians have introduced and used concepts in physical science which transcend all possible experience.[13] It is the primary function of a particular metaphysic in relation to a positive natural science to provide a set of basic concepts and connected theorems which mathematics may safely build upon to develop a science, while remaining within the range of possible experience. The concept of empty space is, for Kant, a good example of an empty concept, that is, one which transcends experience; for empty space can never be an object of sensuous intuition, nor be properly derived from objects which are.[14] This is exactly the kind of logically neat concept which the mathematician, untutored in critical metaphysics, will introduce into natural science.

The positive role of mathematics in natural science is, of course, large. Kant emphasizes the necessity of mathematics by asserting that in every special doctrine, such as that of matter, there is only so much proper natural science as there is applied mathematics.[15] The reason is that in order to know a priori a determinate thing or object, such as matter, we must be able to know it from its mere (physical) possibility.[16] And the a priori knowledge of the physical possibility of a thing, in contradistinction to its merely logical possibility, can be obtained only by constructing the concept of the thing, that is, by an a priori intuition corresponding to the concept, which is nothing else than mathematics.[17] Mathematics is needed to provide the means for constructing the positive body of knowledge of proper natural science; philosophy is needed to provide a systematic set of concepts and principles which the mathematician may use and which do not transcend experience. The primary task of the *Anfangsgruende* is to carry the concept of matter through the table of the categories and thereby to provide the elements of a mathematical physics that is wholly in conformity with experience.

2. I turn now to Kant's use of the categories to find the specific determinations of matter. Within the Kantian framework a serious problem confronts us at once. How are we to begin? If the concept of matter is only clear and definite after it has been subsumed under the four functions of judgment, how can we represent any properties of matter as universal, essential, and necessary prior to this subsumption? That is, how do we

know where to begin? As August Stadler has remarked, Kant disposes of this particular problem with a casual, offhand remark that is not very satisfactory. Kant asserts: "Die Grundbestimmung eines Etwas, das ein Gegenstand aeusserer Sinne sein soll, musste Bewegung sein; denn dadurch allein koennen diese Sinne afficirt werden. Auf diese fuehrt auch der Verstand alle uebrige Praedikate der Materie, die zu ihrer Natur gehoeren, zurueck. . . ."[18] Since Kant remarks several times in the *Critique* that the concept of motion is derived empirically and is not pure and a priori,[19] from the standpoint of the Preface of the *Anfangsgruende* the relation between the concepts of matter and motion is baffling. The fundamental determination of an object of the external sense must be motion, he says, for only in this way can the external sense be affected. Now is this assertion analytic, a priori synthetic, or a posteriori synthetic? It can hardly be a priori synthetic, for it is not a proposition of mathematics, and its possibility as a valid synthetic metaphysical proposition seems to be ruled out by its assertion antecedent to the use of the categories. If it is a posteriori synthetic, Kant has violated his requirement that the *Anfangsgruende* takes from experience only the concept of matter and develops all else according to a priori principles. The only consistent alternative is that it is analytic, and this may be what Kant intends. He may hold that the concept of matter includes the concept of an object of the external sense, and that this latter includes the concept of motion. However, all of this is unstated, and the reader can only be uneasy over the nature of this fundamental assumption of the *Anfangsgruende*. In any case, Kant asserts that its introduction effectively reduces all proper natural science to a pure or applied theory of motion.[20] It is then as the doctrine or theory of motion (*Bewegungslehre*) that the *Anfangsgruende der Naturwissenschaft* is brought under the four divisions of the table of the categories. In the first division, matter is considered purely according to its *quantity* of motion, abstracted from all its qualities. This gives us the theory of phoronomy. In the second division, motion is considered as belonging to the *quality* of matter, *"unter dem Namen einer urspruenglich bewegenden Kraft."*[21] This yields dynamics. The third division is mechanics; here, motion as quality is considered in *relation* to other reciprocal motions, or, more exactly, matter with this dynamical quality of possessing an original moving force is considered in reciprocal motion. In the fourth division, entitled phenomenology, matter in motion or at rest is considered according to its *modality*; that is, whether in its determination as phenomenon of the external sense it is determined as possible, real, or necessary.

It is the main function of the *Anfangsgruende* to elaborate this subsumption under the categories of the main divisions of mechanics, which is for Kant identical with mathematical physics. What this analysis par-

ticularly substantiates is Randall's claim that in setting forth the categories in the *Critique of Pure Reason*, Kant was "really analyzing the necessary relations in the system of Newtonian mechanics."[22]

3. Kant's analysis of the foundations of physics in the *Anfangsgruende* assigns a central role to fundamental forces of repulsion and attraction. He does not make the mistake of attempting to derive a priori specific mathematical laws that will characterize the nature of these forces, but he does derive, or at least argue for, a number of fundamental theorems, including Newton's third law of action and reaction. Without a detailed discussion of the derivation of these forces, we can still consider the central question of what is the epistemological or metaphysical relation of the fundamental forces of repulsion and attraction to the concept of matter itself. Kant emphasizes that the fundamental forces of repulsion and attraction cannot themselves be constructed; their possibility cannot be demonstrated. These fundamental forces are not derived from experience, nor can they be mathematically constructed from other concepts, which would be necessary to demonstrate their possibility. They are jointly the ultimate ground for the possibility of matter. If one asks why matter fills its space by these original forces, the only answer is that they are necessary conditions for the construction of the concept of matter. Reason can do no more than reduce the diverse forces appearing in nature to these two fundamental ones, "beyond which our reason cannot go."[23]

His own words clearly define his position: "That the possibility of the fundamental forces should be made comprehensible is a wholly impossible demand; for they are called fundamental forces, precisely because they can be derived from no others, that is, cannot be comprehended (*begriffen*)."[24]

If the fundamental forces cannot themselves be comprehended or explained, if they are each the source of an ultimate explanatory principle, and if the concept of them is used to construct the concept of matter, then the delicate problem arises: of what are these forces predicated? Is it a vicious circle to say they are forces *of* matter? Would it be more nearly correct to say that these forces *are* matter? This is not the same as asking for an explanation of the forces. Rather, accepting them as ultimate, we are asking the different question: to what do they belong, if anything? Boscovich answered this question by making forces ultimate in nature, but retaining as carriers of the forces a finite set of points of singularity. For Boscovich, forces are predicated of these points, which for him solves the question that we are now asking Kant. Kant eliminates all points of singularity in space which might serve as ultimate subjects of the forces. Empty space cannot be an object of experience, and every part, that is, every point, of filled space possesses forces of attraction and repulsion.

Now it is tempting to say that in abolishing all points of singularity and predicating forces of every point of space that can be experienced, Kant has unequivocally adopted a complete dynamical theory of matter and has asserted that forces are matter. There are passages in the Dynamics that lend definite support to this view. For instance, the General Remark on the Dynamics begins: "The universal principle of the dynamics of material nature is: that all reality of the objects of the external sense, which is not mere determination of space (place, extension and figure), must be regarded as moving force. . . ."[25] However, there does not seem to be a fully adequate case for this view. The discussion of substance in the *Critique* forms one of the chief blocks to such an interpretation. The first analogy of experience states the principle of the permanence of substance. This analogy is the rule corresponding to the category of inherence and subsistence. The principle states that in all changes of phenomena, substance is permanent and is neither decreased nor increased.[26] Substance is simply the substratum of all determinations in time, that is, of all changing phenomena. Kant's argument is that the bare succession of phenomena must have a permanent substratum as a necessary condition, for this substratum is "the condition of the possibility of all synthetical unity of perceptions, that is, of experience."[27] Without this substratum, the manifold of phenomena given in time could not be determined according to any rules, and could not be connected as objects enduring in time. Now the second analogy of experience, which corresponds to the category of causality, is that all changes take place according to the law of causality. For the moment, the important point of this is that changes must be changes in the determinations or states of the permanent substance, one state following another according to a given rule. The permanent substance provides the ground for the connection of successive states; in fact, if substance were created or destroyed, the universality of the law of causality would be violated.[28]

But what is the empirical criterion of substance? "Action . . . is a sufficient empirical criterion to prove substantiality, nor is it necessary that I should first establish its permanency by means of compared perceptions, which indeed would hardly be possible in this way, at least with that completeness which is required by the magnitude and strict universality of the concept."[29] Action directly implies the relation of the subject of causality (substance) to the effect. But for action there is needed the permanent substratum, for "actions are always the first ground of all change of phenomena, and cannot exist therefore in a subject that itself changes, because in that case other actions and another subject would be required to determine that change."[30] Actions, forces, cannot subsist by

themselves but must be determinations of a permanent substratum. On the other hand, Kant says, substance "appearing in space," that is, matter, can only be known to us through the two fundamental forces of attraction and repulsion. Other properties of matter are unknown to us.[31]

Without going further into the systematic discussion of substance in the *Critique*, I believe we may now answer the question we asked about the fundamental forces. Matter, as spatial substance, as the ultimate subject of the science of physics, is not simply the two fundamental forces. It is true that the concepts of these two forces are precisely those which permit us to construct the concept of matter, that is, represent it in intuition; and simply as an object of intuition, matter is equivalent with them. However, matter as substance is also the permanent substratum of all spatial phenomena. The fundamental forces are not this permanent substratum, but rather it is "the amount of the fundamental forces" possessed by a given part of this substratum that determines its particular state. The mathematician or physicist, dealing as he does only with pure or empirical intuitions, might successfully equate the fundamental forces and matter; but the philosopher, probing at the foundations of the data of intuition, knows that the fundamental forces are not the ultimate subject in space, but are the specific determinations of that subject (the permanent substratum). And this conclusion is supported in the third division of the *Anfangsgruende*, where Kant specifically states that the quantity of substance in a matter, that is, the quantity of the permanent substratum, is not a function of the amount of the fundamental forces in that matter, but must be estimated mechanically, that is, by the amount of its motion.[32]

It seems to me that this discussion of force and matter in Kant—the delicate effort he makes to assign a fundamental place to force, and yet not eliminate an independent concept of matter—is still pertinent today. It is particularly relevant to the tangled problems of thinking about force, matter, and energy, in any conceptually clear way, in the context of contemporary nuclear physics. I don't mean to suggest that detailed answers for today's puzzles are to be found in reading Kant. I do think that some of the too-simple models we associate with the Cartesian and Newtonian tradition would be more easily rejected as inadequate on general philosophical grounds if we took seriously Kant's careful and discriminating analysis.

4. The simple ideas of atomism and Cartesian physics have played far too dominant a role in our thinking about the fundamental kinds of explanations we are willing to accept for physical phenomena. More clearly, I would say, than any other philosopher, Kant drew the lines in a nearly consistent fashion between mechanical and dynamical explanations

of nature. He stated the virtues and strengths of the dynamical approach more explicitly than any preceding philosopher, and what he has to say is of interest today for some of the reasons just stated.

In the seventeenth and eighteenth centuries, "mechanics" and its derivative words were not defined as generally as they are today, and there was considerable controversy over what should be counted as mechanical explanations and as part of the science of mechanics. The Cartesians were the great reductionists in this debate; for they insisted on restricting mechanics to kinematics, plus only one kind of force or action: the motion communicated by one body to another through direct contact. Newton tried to stay out of this controversy by insisting that he studied only the mathematical, not the physical properties of forces, that is, the causes of motion. Newton's followers, however, challenged the Cartesian view; Boscovich, for instance, insists that mechanics is not limited to the study of impulsive actions, but may include the study of any forces which produce motion and change of motion according to general laws. Boscovich does have certain reservations about committing himself on the ultimate "physical" modes of action. It is Kant who states the problem most clearly and faces the issues most directly. As Kant sees it, the only two ways to explain the specific phenomena of nature are the mechanical and the dynamical. Here we use the word "mechanical" in the limited Cartesian sense, not in the general way it is used today. As stated above, the (Cartesian) mechanical method of explanation limits itself to assuming that the non-uniform motion of a body is entirely due to the actual motions of other bodies communicated to it only by direct impulse; the introduction of any other cause of motion smacks of the occult qualities of the Scholastics. The dynamical method, on the other hand, assumes that the non-uniform motion of a body may also be due to the repulsive and attractive forces of other bodies, these forces being fundamental physical properties of the bodies, which are independent of their actual motions.

An examination of Kant's discussion of this mechanical-dynamical controversy affords an opportunity to present Kant's own evaluation of his construction of the concept of matter by original moving forces.[33] The genuine problem is not simply to account for matter filling space, but to account for the specific varieties of matter that fill space.[34] The mechanical method of explanation, Kant says, assumes that matter is composed of primal bodies (atoms) possessing the following properties: absolute impenetrability, absolute homogeneity, and absolute unconquerability (by any forces) of the cohesion of the matter of these primal bodies.[35] From primitive matter of this kind, the mechanical method attempts to deduce an explanation of the specific varieties of different matter found in the universe. In this deduction, the assumption most

characteristic of the mechanical method is added: the assumption that the different densities of different matters can only be accounted for by the distribution of empty spaces between the homogeneous primal bodies. Since the primal bodies cannot themselves be observed, the validity of the mechanical method really hinges on the supposed necessity of this last assumption of interspersed empty spaces. To establish a dynamical mode of explanation, with its several advantages, it is thus required only to refute the supposed necessity of this assumption by showing how density differences can be conceived and explained in another way.[36] This is easily done. The theorems of the Dynamics have shown that matter may be conceived to fill its space, not by absolute impenetrability, but by a repulsive force. The definite degree of this filling is a function of the balance of the repulsive and attractive forces. The attractive force is regulated by the quantity of matter considered, but the repulsive force may vary in a continuous and unlimited fashion. Thus the different densities of two different matters are accounted for by a difference in the degree of their repulsive forces. In fact, Kant asserts, in this way one can conceive a matter such as the ether which wholly fills its space without any void, and yet has for a given volume a quantity of matter which is far less than that of any body we can subject to experiment. All we need do for a matter such as the ether is to conceive its repulsive force as incomparably greater than its attractive force.[37] In general, therefore, there is no question that the supposed necessity for the assumption of empty spaces is directly refuted.

With this out of the way, we may exar ıe the comparative advantages of the dynamical method. The largest critical or negative advantage of the dynamical method is that natural science is relieved of the burden of manufacturing a world "from fullness and emptiness according to fancy."[38] This negative advantage results from having got rid of the necessity for assuming empty space, which can never be an object of experience nor therefore of any possible experiments. The positive advantage of this method is the extension of the field of the scientific investigator to the proper, fundamental forces of matter itself. Traditional mechanical theories, from Democritus to Descartes, have denied such forces and thereby unduly limited the concepts available to the scientist. However, it must be carefully noted, Kant asserts, that this positive advantage cannot be extended to the construction of the specific varieties of matter, but only to the concept of matter in general. The specific determinations of the fundamental forces cannot be constructed on a priori grounds, and consequently the specific varieties of matter can never be deduced in an a priori manner.[39] In fact, on a priori grounds, the mathematico-mechanical method can go further than the metaphysico-dynamical method; for

the distribution of ultimate parts of matter of given figure and size can easily be represented in intuition, which permits the construction of specific matters. But, as has been noted, the mechanical method pays for this single advantage at a high price. It makes fundamental the empty concept of absolute impenetrability, which is nothing else than a *qualitas occulta*: it must use the concept of empty space, it gives up all the proper forces of matter, and in general it must give more free reign to fancy and imagination than is consistent with the caution necessary in science and philosophy.[40] Kant sums up this evaluation by saying that the most that metaphysical research can hope to do is to lead natural science to the dynamical method of explanation, which alone is capable of definite laws lying within actual experience and cohering in a rational manner.[41] Metaphysics can carry us no further than the general framework of the theorems of the *Anfangsgruende*; for besides these, "no law whatever of the attractive and repulsive forces may be ventured on a priori conjectures, but everything, even the universal attraction as cause of gravity must, together with its law, be inferred from the data of experience."[42]

This final passage may serve as a warning as to how cautious we must be in interpreting the range of Kant's commitment to an a priori physics. He emphasizes in this passage as elsewhere that even so fundamental a law as the law of universal gravitational attraction cannot be derived from the concept of motion subsumed under the categories, but must itself be inferred from the data of experience. Randall's own emphasis on Kant's deep respect for the facts—all the facts—of experience is indeed one of the excellent features of his analysis of Kant's philosophy of science.

NOTES

1. References are to the first edition (Riga, 1786). In the two other editions of this work, 1787 and 1800, published during Kant's lifetime, no changes were made in the text. Use has also been made of Belford Bax's translation, *Metaphysical Foundations of Natural Science* (London, 1900), but this translation is not very satisfactory. I am responsible for the few translations given in this article. Translations of short passages from *The Critique of Pure Reason* are taken from the Muller translation, 2nd edition, revised (New York, 1949).

2. *Anfangsgruende*, p. VIII.

3. *Critique*, A720-1, B748-9.

4. *Ibid.*, A161, B200. The table of principles, derived from the table of categories, provides all the fundamental principles of the pure understanding, insofar as the actual representations given in intuition are disregarded. Once these are considered, we derive from this table the principles of mathematics and of general physical dynamics. Cf. A162, B201-02.

5. For statements on this, see *ibid.*, A13-14, A81-82, B27-28, B107-08.

6. *Ibid.*, A848, B876.

7. *Anfangsgruende*, p. VIII.

8. *Ibid.*, p. XIV.

9. "Denn mehr giebt es nicht rein Verstandesbegriffe, die die Natur der Dinge betreffen koennen" (*ibid.*, pp. XV-XVI).

10. *Ibid.*, p. VII.

11. *Ibid.*,pp. 116-7; see also *Critique*, B224-5.

12. *Anfangsgruende*, p. XII.

13. *Critique*, A847, B875, footnote.

14. *Ibid.*, A172, B214; *Anfangsgruende*, 81-83, 105, 145-158.

15. *Anfangsgruende*, p. VIII.

16. Kant does not actually speak of "physical" possibility. It might be better to use "real possibility," meaning "capable of being presented in intuition." The deviation from Kantian terminology is merely in the interest of clearer exposition.

17. *Ibid.*, p. IX.

18. *Ibid.*, p. XX. Stadler's comment on this passage: "Warum musste sie das sein? Woher stammt die behauptete Notwendigkeit? Wer lehrt uns, dass die Sinne allein durch Bewegung afficirt werden koenen? Wenn eine Grundbestimmung eingefuehrt wird, so koennen wir uns doch nicht bei der blossen Thatsache beruhigen, sondern muessen eine Legitimation verlangen. Allein es findet sich kein Wort der Erklaerung." *Kants Theorie der Materie* (Leipzig, 1883), p. 6.

19. Cf. also *Anfangsgruende*, p. 4.

20. This statement is legitimate, for Kant dismisses the possibility of empirical psychology being a proper natural science. This leaves only physics. See *ibid.*, p. X-XI.

21. *Ibid.*, p. XXI.

22. *The Career of Philosophy*, Vol. II, p. 140.

23. "Denn es ist ueberhaupt ueber den Gesichtskreis unserer Vernunft gelegen, urspruengliche Kraefte a priori ihrer Moeglichkeit nach einzusehen, vielmehr besteht alle Naturphilosophie in der Zurueckfuehrung gegebener, dem Anscheine nach verschiedener Kraefte auf eine geringere Zahl Kraefte und Vermoegen, die zu Erklaerung der Wirkungen der ersten zulangen, welche Reduktion aber nur bis zu Grundkraeften fortgeht, ueber die unsere Vernunft nicht hinaus kann." *Anfangsgruende*, p. 104.

24. *Ibid.*, Lehrsatz VII, *Anmerkung* 1, p. 61.

25. *Ibid.*, p. 81.

26. *Critique*, B224.

27. *Ibid.*, A183, B226-27.

28. *Ibid.*, B232-33.

29. *Ibid.*, A205, B250-51.

30. *Ibid.*, A205, B250.

31. *Ibid.*, A265, B321.

32. *Anfangsgruende*, Drittes Haupstueck, Lehrsatz I, *Anmerkung*, pp. 114-115. In this passage Kant practically concedes the empirical point again—that is, that the

only properties of matter known to us are the fundamental forces (and that which is derived from them). For he admits that in determining the quantity of matter by the standard procedure of weighing it, we are dependent on the fundamental force of attraction, and thus determine it mechanically only indirectly.

33. The relevant remarks are primarily to be found in the "Allgemeine Anmerkung zur Dynamik," *Anfangsgruende*, pp. 81-105.

34. *Ibid.*, p. 100.

35. *Ibid.*, pp. 100-01.

36. *Ibid.*, p. 102.

37. *Ibid.*, pp. 102-03.

38. *Ibid.*, p. 83.

39. *Ibid.*, pp. 83-84.

40. *Ibid.*, pp. 84-85.

41. *Ibid.*, pp. 104-05.

42. *Ibid.*, pp. 103-04.