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TOWARD A WIDENING OF THE NOTION OF CAUSALITY

I. THE ORIGINS OF CLASSICAL DETERMINISM

If we wish to speak of the widening of the idea of causality, we must first specify the exact meaning of this concept, the modification of which is now being considered by many contemporary philosophers and scientists. In order to shed light on the classical concept of causality, it is almost impossible to avoid approaching it from the genetic point of view. Without a historical perspective we have only a very limited understanding of the content of the classical concepts by which this philosophic as well as scientific tradition has been constituted. By showing the deep and tenacious roots of our belief in rigorous determinism, we shall better understand certain types of resistance which today are opposed to any attempt at making determinism more flexible.

It is no exaggeration to say that the belief in strict determinism is almost as old as Western thought itself. Without discussing the mythical belief in an impersonal "destiny" to which even the gods were sub-

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mitted, we find the first precise formulation of determinism in Democritus, when he writes: "All things are determined by necessity, things that have been, things which are, and things which are going to happen." Twenty-two centuries after Democritus, Laplace expressed the same conviction, based on a conception of the universe which does not differ essentially from that of Greek atomism:

> Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it—an intelligence sufficiently vast to submit these data to analysis—it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes.[1]

It is true that there is a very important difference between the determinism of Democritus and that of Laplace. The latter possessed a conceptual apparatus far more complex and flexible than the former. This is only natural; in the interval of time which separated Greek determinism from modern determinism, there occurred two events, which were, moreover, very closely associated with each other: the discovery of infinitesimal calculus and the founding of classical mechanics. The laws of mechanics, especially the law of inertia and of the conservation of the quantity of motion and of energy, were only guessed at by the Greek atomists, and their precise formulation had to await the cosmological revolution of Copernicus and Giordano Bruno. It is still true, however, that Democritus insisted just as vigorously as did Laplace and the modern deterministes on the absence of contingency in nature. It is also true that in other respects Democritus anticipated certain aspects of Newtonian physics, for example, the infinity and the homogeneity of space, as well as the qualitative unity of matter, its permanence, and its atomic structure. Thus we see the justification of the Meyerson thesis, according to which, philosophically speaking, the difference between Greek atomism and classical physics is one of degree and not of nature, which means that, given the close connection between the corpuscular models of nature and absolute determinism, the distinction between the "necessity" (ἀνάγκη) of Democritus and the "necessity" of Laplace is also a difference of degree.

Laplace's formula, so frequently quoted, has been expressed many times in more concrete and more colorful language, pointing out clear-

1. Pierre Simon, Marquis de Laplace, *A Philosophical Essay on Probabilities*, trans. F. W. Truscott and F. L. Emory (New York: John Wiley & Sons, 1902), p. 4.

ly that not only inorganic nature but also the most concrete details—and, in appearance, the most contingent details—of human history are only parts of the same network of universal necessity by which all effects are joined to their causes. According to Du Bois-Reymond, Laplacian intelligence would be capable of deducing the most insignificant details as well as the most important events of human history from its huge system of differential equations. It matters little if the events to be deduced belong to the past or to the future. The universal intelligence would know if the sky were clear or cloudy when Pericles embarked at Piraeus to go to Epidaurus; it would also know the exact future date on which the Orthodox cross would be raised over the Mosque of St. Sophia in Constantinople.[2] (We should bear in mind that the date of Du Bois-Reymond's lecture—1877—explains this belief in the inevitability of a Russian conquest of Constantinople.) It is obvious that, from the strictly deterministic point of view, social history is only a particular case of universal physical history. The human body, including the nervous system, is composed of the same elementary particles as inert matter, and, consequently, it obeys the same physical laws; thus Hippolyte Taine was merely consistent when in 1870 he wrote: "In supposing the science to be complete, we should arrive at a mathematical formula enabling us to sum up in some one law the different positions and relations of all the nervous particles."[3]

The idea of inescapable necessity even penetrated literature, where the theme of the inevitability of personal destiny and of all human thoughts and actions became very popular in the naturalistic and in the psychological novel. Let us mention just two examples: Tolstoi and Anatole France. The philosophic epilogue of *War and Peace* is pervaded by the same idea of universal necessity as the philosophic discourses of Dr. Socrates in the *Histoire comique,* when he insists that the whole cosmic past has, as it were, conspired to make M. Chevalier's suicide inevitable. "Even when the solar system was only a pale nebula with a radius a thousand times greater than that of Neptune," says Anatole France, speaking through Dr. Socrates, "the actions of all men, including this particular and tragic one of M. Chevalier, were already inexorably predetermined—for the human mechanism is only a special case of the universal mechanism."

2. E. Du Bois-Reymond, "Über die Grenzen des Naturerkennens," *Wissenschaftliche Vorträge,* ed. J. H. Gore (London, 1896), p. 38.

3. H. Taine, *On Intelligence,* trans. T. D. Hege (New York, 1871), p. 104.

However, it would be a serious mistake to think that rigorous determinism had never been associated with any philosophic system other than the mechanistic and materialistic ones. It is found just as often in the idealistic philosophers. What is seemingly even stranger is the fact that we find a formula just as intransigent as that of Laplace in one of the so-called defenders of human freedom, Immanuel Kant. In a rather little-known passage of his *Critique of Practical Reason,* Kant, long before Laplace, applied Laplacian determinism not only to the human body but also to the human intelligence:

> It may therefore be admitted that if it were possible to have so profound an insight (*so tiefe Einsicht*) into a man's mental character as shown by internal as well as external actions, as to know all its motives, even the smallest, and likewise all the external occasions that can influence them, we could calculate a man's conduct for the future with as great certainty as a lunar or solar eclipse; and nevertheless we may maintain that the man is free.[4]

This passage will seem less paradoxical if we remember that, according to Kant, the category of causality applies to the world of phenomena without any restriction—not only to the "external" phenomena which constitute the contents of our outward perception but also to the introspection, which is placed by Kant on the same phenomenal level as sensory experience. The question has frequently been raised as to what this famous "intelligible freedom," to which Kant alludes in the last words of the text just quoted, could be. For the moment we shall not discuss the question whether freedom is compatible with the denial of time, as Kant himself believed; but we shall return to this point later. Let us merely retain one very important fact: that, as far as the "phenomenal world," including human psychophysical nature, is concerned, Kant was as deterministic as La Mettrie, or any other materialist or mechanist. Even Johann Gottlieb Fichte, certainly one of the most intransigent idealists, did not hesitate to affirm predetermination and the complete predictability of all psychological states.[5] In an entirely consistent fashion, although it appeared to be somewhat disrespectful, Friedrich Paulsen, one of the founders of Neo-Kantism, applied the Laplacian explanation to the mind of his master himself, when he wrote that an

4. Immanuel Kant, *Kant's Critique of Practical Reason and Other Works on the Theory of Ethics,* trans. T. K. Abbott (London: Longmans, Green & Co., 1909), p. 193.

5. J. G. Fichte, *Die Bestimmung des Menschen, Sammtl. Werke* (Berlin, 1943), II, 182–83.

omniscient physiologist would explain . . . the author of the *Critique of Pure Reason* just as he would explain a clock-work. In consequence of this particular arrangement of the brain-cells and of their interconnections with each other and the motor nerves, certain stimuli exciting the retina and the tactile nerves of the fingers had to occasion certain movements, which are in no wise different from those of a writing-automaton or a music-box.[6]

It is quite clear that the doctrine of psychophysiological parallelism, according to which there is no interaction between the consciousness and matter, found another argument in its favor in the Kantian doctrine of causality. If the category of causality is applied to the whole phenomenal world, it must be applied to all motions of matter, including the molecular displacements in the cerebral tissue of Kant himself. Thus human freedom is denied by the Kantians and Neo-Kantians as effectively as by the materialists and the mechanists. The only difference between materialism and Kantism is that for the latter the physical world is only a world of phenomena, while for the former it is a reality in itself, a *Ding an sich*. But interaction between the consciousness and the brain is as radically eliminated by Kant and the Neo-Kantians as by the physiological psychology of the nineteenth century.

Curiously enough, even some of those who are opposed to the parallelist doctrine and who defend a kind of psychophysical interaction nevertheless accept the doctrine of absolute determinism. Hans Driesch, for example, although opposed to mechanistic explanations in biology, has nevertheless stressed that his *vitalism* is not to be confused with indeterminism. Moreover, in a passage in his principal work, *Die Philosophie des Organischen,* he has explicitly stated that the complete knowledge of a certain state of the physical world, added to the complete knowledge of all the states of all the entelechies at the same instant, would make possible for us the integral prediction of any future moment.[7] It is difficult to find a more convincing proof that rigorous determinism is not the exclusive domain of materialism or of naturalism. As we have seen, it can be combined with the idealistic doctrine or even with a vitalist interactionism.

It would be pointless to give more examples. What we have already said is sufficient to show that the doctrine of absolute necessity, which implies the integral predetermination of the future, represents a tend-

6. Friedrich Paulsen, *Introduction to Philosophy,* trans. F. Thilly (New York: Henry Holt & Co., 1912), p. 88.

7. H. Driesch, *Die Philosophie des Organischen,* p. 290.

ency which is present in idealism as well as in naturalism, at least in their classical forms.

A brief survey of the history of philosophy will show that this conclusion is not so paradoxical as it may seem. Rigorous determinism has appeared three times in the history of Western thought: in ancient Greece, in the Middle Ages, and in the science of Galileo and Newton. As we have already stated, it appeared for the first time in the system of Leucippus and of Democritus. By placing the name of Democritus beside that of Laplace, we have already indicated that the modern form of determinism differs only in degree from its classical form. Even if we take into account all the distance which separates the speculative atomism of the Abderite from the experimental atomism of Dalton and from the kinetic theory of gases, the agreement on all essential points obscures the differences of detail and even the difference of method. This difference of method is not so absolute as is often claimed. We must not forget the speculative origins of modern atomism and the influence ancient atomism has had on it. This influence was especially evident in the formative seventeenth-century period; everyone knows the historical bonds between Gassendi's atomism and that of Lucretius. But the influence of Democritus, that is, of the atomist whose system was not spoiled by the curious notion of the undetermined *clinamen,* was no less strong. The name *Democritus reviviscens* which Johannes Chrysostomus Magnenus gave to his book is certainly significant and expresses very well the idea of the return to classical atomism which inspired the physics of the seventeenth century. The global vision of reality is, on all essential points, the same in Greek atomism as in Newtonian physics: the universe is composed of little grains of homogenous matter which move according to strict laws. All diversity of nature is due to differences in *configuration* and in motion. Any *qualitative* transformation is only an appearance produced by the changes in position of particles which always remain the same. Any contingency and any novelty are merely illusions due to our ignorance. Thus it is scarcely an exaggeration to say that the first and the third forms of determinism differ only in details which, however important they may be for the historian of the sciences, are of secondary importance from the philosophical point of view.

In the period which separated Greek atomism and Newtonian mechanics, there appeared a second form of determinism which seemed to be completely different. This was the *theological determinism,* which

found its most striking expression in the doctrine of predestination. This form of determinism has certainly been no less rigid than the naturalistic determinism of the Greek and of the modern period. All the concessions—verbal ones, moreover—which have been made by theologians to the notion of human freedom were inspired by motives which were completely foreign to the doctrine itself. Human freedom, in the systems of Augustine, of Thomas, and of the Protestant reformers, is as incompatible with the doctrine of absolute predestination as the *clinamen* of Lucretius was with his mechanistic system. The modern doctrine of absolute necessity is, according to Professor Charles Hartshorne, the result of the "secret alliance" between naturalistic determinism and theological determinism.[8] An assertion of this kind is less surprising when we take into account the common historical origin of these two determinisms. We intend to show that this common source is the philosophy of Parmenides of Elea, whose decisive influence on the development of Western thought is probably without parallel.

The Eleatic origin of Greek atomism is generally recognized. It is known that Leucippus and Democritus, according to Windelband's picturesque expression, "broke Parmenides' sphere into little pieces" which move through empty space according to strict laws. Parmenides' principle of the permanence of Being became the principle of the conservation of matter of the atomists, who, on this point also, anticipated another discovery of modern science. It is true that there are important differences between Democritus and Parmenides. The latter is a monist, while the former was a pluralist. Parmenides denied all change; Democritus admitted at least the reality of change of position. But, despite these differences, there is a profound kinship. Democritus' atom is as permanent, that is, as uncreatable and indestructible, as Parmenidean Being. The quantity of matter which it contains always remains the same. Its essential quality, that is, its *plenitude,* remains as absolute and as immutable as the same quality in the Eleatic Being. If the atomists admitted change, they admitted it in its most innocuous form, that is, in the form of *change of place,* which affects neither the total quantity nor the quality of Being. The change admitted by the atomists is change in the spatial relations of atoms, that is, change which is only half-real. For the void of the atomists, although different from the pure non-

8. Charles Hartshorne, "Contingency and the New Era in Metaphysics," *Journal of Philosophy,* XXIX (1932), 429.

Being of Parmenides, does not have the same degree of reality as matter itself. Consequently, the changing of relations in the void is doubly removed from the *primordial* reality of the substantial *plenum*. Since the time of Democritus, change, as well as multiplicity, is admitted by philosophers; no one, not even Spinoza or Bradley, returned to static monism, as radical and as arrogant as that of the Eleatics. However, the influence of the latter was strong enough to induce most philosophers to regard change and plurality as semireal, that is, as not possessing the same dignity as the underlying Being which remains one and immutable. As Émile Meyerson has shown in his classical works, static monism has remained an ideal model which, although never attained, has inspired philosophic systems as well as scientific explanations.

The continuity of theological determinism with Eleatic philosophy is probably less known and less evident, but it remains no less real. Space does not permit us to give a detailed historical analysis; we shall merely sketch the essential points. What is certain is that the fusion of the idea of Good with that of One, proposed for the first time by Euclid of Megara, and later accepted by Plato and Plotinus, had a profound influence on the formation of Christian theology. In spite of all the differences between Neo-Platonism and the philosophy of Aristotle, the medieval idea of God has the same Eleatic traits. That is why all the eminent Christian philosophers, such as Augustine, Johannes Scotus Erigena, Anselm, and Thomas, identify God with Being, which is One, indivisible, and absolutely immutable—for no change, however insignificant it may be, is compatible with the supreme perfection and incorruptibility of the divine Being. We must not forget that all change, all development, all succession, were regarded by the Christian theologians—as they were, moreover, by the Jewish and Moslem theologians —in a completely Platonistic and Eleatic way, as a corruption unworthy of the absolute perfection of the supreme Being. If we read the first twenty-six questions of the *Summa theologica* of Thomas, we become sufficiently aware of the extent to which the attributes of his God are the attributes of the Eleatic Being. There is no doubt that the religious difficulties in what may be called "theological Eleatism" were very serious. It is almost moving to see Thomas struggling desperately between the biblical idea of a personal and acting God and the Greek idea of a God conceived as an immutable, metaphysical principle and to see him trying to breathe some life and warmth into the cold concept of

Greek metaphysics.[9] In identifying their God with non-temporal Being, the theologians had no other choice than to place his wisdom and his knowledge outside of time. His knowledge must be limited by time; it embraces in a single, indivisible glance the totality of past, present, and future events, which are past, present, and future only for our imperfect human intelligence. Thus omniscience implies foreknowledge, and foreknowledge implies detailed providence, and, consequently, predestination. Within the divine intelligence there is no succession; there is no unrolling of time. All is traced out in advance in the most minute details and cannot be changed. Answering those who ask if prayer for the intervention of the saints can change the eternal decision of God, Thomas says that, if there is a change, it exists only in appearance, because even prayer and the interventions of the saints have been foreseen by the omniscient God, and thus they form a part of total and indivisible predestination. Although this uncompromising doctrine was relaxed in the official semi-Pelagianism of the period which preceded the Reformation, it was taken up again with the same vigor by Luther and especially by Calvin and Zwingli.

The transition from theological determinism to modern naturalistic determinism was not a sudden one. The most important transitional phases were the pantheism of Bruno and, a century later, that of Spinoza. In medieval theology pantheism was only virtual, although several eminent thinkers were coming close to it; but, as long as the duality of the world and of God remained preserved by the very structure of the Aristotelian world, that is, by the duality of the celestial world and the sublunar world, lurking pantheism could not become explicit. But when Giordano Bruno swept away the last sphere of the fixed stars, which was still retained by Copernicus, and when he thus proclaimed the unity of nature in the infinity of cosmic space, the way was open to the explicit and heretical pantheism which would replace the *Deus et Natura* of the Scholastics with the *Deus sive Natura* of Spinoza. We know the profound upheaval which this passage from medieval theism to modern pantheism produced in the sixteenth and seventeenth centuries. But we must not forget that the revolutionary character of modern pantheism was only apparent, because it was virtually present in the thought of theologians before the Renaissance. That explains why the God of Bruno and of Spinoza possessed the same Eleatic traits

9. See *Summa theologica*, Part I, particularly Questions IX, XVIII, XIX, XX, and XXII.

as the God of medieval theology and of Neo-Platonistic philosophy. "The divine Spirit," Bruno writes in his *Summa terminorum metaphysicorum,* "sees all things at once, in a single, simultaneous glance, that is, without distinction between past, present, and future; all things are present for it."[10] As in the preceding philosophical and theological systems, the notion of predestination followed inevitably from that of divine omniscience, but, in the thought of Bruno and of Spinoza, divine predestination was identified with the immanent determinism of nature. This was only natural—for nature and God are but two words for a single cosmic substance. Theological determinism, pantheized in this way, has found itself in natural agreement with the determinism of modern science, the fundamental principles of which were established at the same time. Let us not forget that Spinoza was a contemporary of Newton. After the deistic interlude, which was so unsatisfactory from the philosophical as well as from the religious point of view, God became the impersonal order of nature. Laplace's omniscient mind is only a metaphorical expression for the causal order immanent in nature, but we may also say that it is simply the God of Thomas and of Augustine secularized. Like the God of Christian theology, the "One" of Plotinus and the "Being" of Parmenides, it remains outside of time, outside of change, outside of duration. Let us remember this conclusion, which is of capital importance: the causal order of classical knowledge is a metaphysical entity which is outside of time and which thus implies a radical denial of succession.

II. SUPERFLUITY OF TIME IN THE DETERMINISTIC SCHEMA

Thus, if we accept strict determinism in all its consequences, we are faced with this question: Why do we have the appearance, or, if one prefers, the *illusion,* of time? What is the true place of succession in a strictly determined world? We have already emphasized the fact that no one after Parmenides had had the audacity to deny the reality of time and of change in such a complete and radical manner as the School of Elea had done. A rather curious compromise was generally preferred: becoming, instead of being completely denied, was banished only from the metaphysical realm of the true Being to be lodged modestly in the region of phenomena. In other terms, ultimate reality was placed outside of time while the true Being was almost always re-

10. *Jordani Bruno Nolani opera Latine conscripte* (Florence, 1889), i. 4. c. 14. 32, 33.

garded as static and immutable. It was only its phenomenal aspect—a surface aspect—which was considered as unrolling in time. It matters little if this true Being was the Sphere of Parmenides, the Matter of Democritus, the *Ens realissimum* of the medieval Scholastics, the Substance of Spinoza, the *Ding an sich* of Kant, the Unknowable of Spencer, the Absolute of Bradley, or the impersonal order of nature symbolized by the Universal Intelligence of Laplace—the conclusion always remained the same: time, change, succession, becoming, do not belong to "reality in itself" but to the semireal region of phenomena. Thus the dynamic aspect of reality was merely *reduced in rank,* or *weakened,* instead of being simply eliminated. Although time did not possess as authentic a reality as the immutable ontological background, it nevertheless existed *in some way,* although this manner of existence did not have the same dignity as the underlying Being. However, when one admits the dichotomy of "reality in itself," which is outside of time, and of the "Region of Becoming," in which phenomena succeed each other, he has merely stated the question without even attempting to solve it. Since Plato's time, the following question had been asked: Why is the real cut into two regions, that of the Immediate and Perfect and that of Change and the Imperfect? William James asked it in a concise and precise way in reference to Hegelianism, but his question also concerns all static monisms:

> Why, if one act of knowledge could from one point take in the total perspective, with all mere possibilities abolished, should there ever have been anything more than that act? Why duplicate it by the tedious unrolling, inch by inch, of the foredone reality? No answer seems possible.[11]

Although various explanations of the relation of the temporal and the eternal have been attempted, those who have done it have most often been satisfied with mere words. It has been compared to the relationship of the Perfect to the Imperfect, of the Original to its Copy; Aristotle would quickly have emphasized that such metaphors have no explanatory value and that the theory of the two regions of reality creates metaphysical difficulties instead of solving them. However, this judgment did not stop Aristotle from remaining more Platonic than he wished to, and, consequently, it did not stop philosophers from continuing to split reality in a more or less Platonic manner into two

11. William James, "On Some Hegelisms," *The Will To Believe and Other Essays in Popular Philosophy* (New York: Longmans, Green & Co., 1915), p. 271.

domains without explaining their relationship and, above all, without explaining the superfluity of the temporal. In the Middle Ages, while duality of the world and of God was maintained, the affirmation of the reality of the world involved the reality of time. But, when philosophers began insisting with Giordano Bruno and with Spinoza on the fundamental unity of God and of nature, the status of the temporal was inevitably weakened because the non-temporal eternity of the divine substance inevitably entailed the static eternity of the world. If people avoided this conclusion, it was for the purpose of avoiding the conflict with immediate experience which remains irreducibly temporal. At least it was admitted that temporal experience was real, even though it was illusory. But how can such an illusion be explained? How could static reality of which all the parts exist simultaneously, in a block, be deformed or mutilated into a fragmentary form of temporal development, without ceasing to be immutable? The proposed explanations were only apparent if they were not purely verbal evasions. Thus Spinoza establishes after Bruno the distinction between *Natura naturans* and *Natura naturata,* and he asserts that God, *insofar as he is infinite* (*quatenus infinitus est*), is completely different from what he is, *insofar as* he constitutes human intelligence. William James aptly observed that the main device of Spinoza's philosophy is in the word *"quatenus"*:

> Conjunctions, prepositions, and adverbs play indeed the vital part in all philosophies; and in contemporary idealism the words "as" and "quâ" bear the burden of reconciling metaphysical unity with phenomenal diversity. *Quâ absolute* the world is one and perfect, *quâ relative* it is many and faulty, yet it is identically the self-same world—instead of talking of it as many facts, we call it one fact in many aspects.[12]

It is obvious that such a reconciliation of non-temporal reality with its successive and changing appearance is purely verbal; but at least these philosophic prestidigitations, by their very vanity, reveal the impossibility of eliminating succession and change. The temporal character of experience is too authentic and too obstinate to be ignored, and the fact that even static monism in its most varied forms at least recognizes its "phenomenal," that is, its semireal, character without simply denying it, is very significant. It was only natural that scientists and even

12. William James, *A Pluralistic Universe* (New York: Longmans, Green & Co., 1909), p. 47.

philosophers inspired by science, and who, for that reason, were less obsessed with subtle metaphysical problems, did not hesitate to admit the reality of time, frankly and without reservations. However, they also believed, as late as the beginning of this century—and there are many who still believe it even today—that the authentically temporal character of the world is compatible with the most rigorous determinism. Is this true? Are temporality and determinism of the Laplacian type truly compatible? We are now facing the basic question of this article. Upon our answer will depend our attitude toward the general question of determinism and indeterminism, as well as our attitudes toward more special problems, such as that of freedom and of contingency in physical nature—the problem which today is at the center of the controversy over the interpretation of Heisenberg's indetermination principle.

At first glance, the question so stated seems strange and almost devoid of meaning because the answer given to it by common sense is completely clear and negative: there is no incompatibility between succession and strict determinism. From the days of the mythical belief in Destiny to the Newtonian concept of strict causality this answer has not varied. This is only natural. Nothing seems more familiar than the notion of the temporal process the phases of which, although strictly determined, are nevertheless successive. All classical scientific thought, not only in the physical sciences, but also in the biological and social sciences, is based on, or appears to be based on, the idea of the *necessary* connection of successive events. The association between the idea of succession and that of causality is so close and so familiar that, before the French contingentists and especially before Bergson, no one questioned their compatibility. Kant, followed on this point by many others, instead of questioning the compatibility of causal necessity and temporal succession, insisted on their *inseparability;* for him, the only way of saving freedom was to put it outside of time. Even after Bergson people continued to believe the same thing and were surprised if the question was raised. Consider what an American philosopher, Ralph Barton Perry, said in his critique of Bergson: "It is entirely possible to maintain the existential priority of time, and be a vigorous determinist as well." According to Perry, even a strictly determined mechanical system *ages,* although it ages according to a precise law. A simple motion of a material particle, of which all the future positions are predictable with

complete accuracy, contradicts, according to Perry, the Bergsonian assertion that temporal evolution and causal necessity are incompatible.[13]

There is no doubt that all the evidence appears to sustain Perry's views and those of his followers. This is especially true if one looks at classical physical science, but it is also true about today's biological and social sciences—for these sciences still remain pervaded by the spirit of classical physics. This is, moreover, only natural. Even among physicists today the question of the strict determination of phenomena is still being debated. Before discussing briefly the changes which have taken place in contemporary physics, we must first expose a serious difficulty which arises for all who claim that the necessary determination of events is compatible with their successive character.

What, then, is the precise meaning of the concept of necessary connection between two successive events? There is agreement on this point: if we affirm that event *b* follows necessarily after event *a,* we are affirming that all the particular traits of the former can be deduced from the latter; supposing our knowledge of a certain event to be complete, there would be no uncertainty even about the most individual and apparently most contingent details of any future event whatsoever. There is no point in quoting Du Bois-Reymond or Anatole France again. This is completely clear in Ralph Barton Perry's example concerning the motion of a material particle; it is obvious there that all the positions as well as the future velocities of the particle in question are predictable. But we know that, according to the determinists, there is in principle no difference between the causal determination of physical events and the necessity of historical events—there are only differences of complexity. It is only their complexity which makes the prediction of events in society so difficult. However, "social physics" does not differ essentially from physics conceived in its original sense. In the one as in the other, the present state implies, without any ambiguity, all future states.

However, by this very assertion, a determinist encounters a difficulty which, in my opinion, is insurmountable. It is known that any logical implication is *ex definitione* non-temporal. It is a commonplace in elementary courses of logic to distinguish logical implication, which is outside of time, from the psychological process of inference by which

13. R. B. Perry, *Present Philosophical Tendencies* (New York: Longmans, Green & Co., 1916), pp. 251–52.

we deduce a conclusion from premises. Although, psychologically speaking, the conclusion is *preceded* by the premises, that is, preceded in the temporal sense, it nevertheless remains true that, logically speaking, there is no succession, no unrolling, in the temporal sense of the word. And let no one be deceived by the ambiguity of the word "flow"; *there is no logical flow in the temporal sense of the word.* If we say that the conclusion "flows" from the premises, we are using this word only in the metaphorical sense. A logical antecedent is not a temporal antecedent; a logical consequence has nothing in common with temporal succession. The premises are not, in the temporal sense, *before* the conclusion, and, in the same way, the conclusion does not *follow* the premises in time. It is more exact to say that the conclusion *pre-exists* in the premises or that it is *contained* in them logically. We *discover* it after the premises in the actual process of human thought, but we do not *create* it by that process itself. The simultaneity of the conclusion with the premises can be illustrated in a convincing way by analyzing a form of classical syllogism: All men are mortal; Socrates is a man; consequently, Socrates is mortal. Or, in symbols: All M are P; all S are M; consequently, all S are P. It is obvious that the expression "consequently" has no temporal meaning. One is easily persuaded of this if he draws the famous Euler's circles, which symbolize the classes, or the logical extensions in question. Not only is class M contained in class P at the *same time* that class S is contained in class M but it is easy to see that class S is contained at the same time in class P. In other terms, the conclusion and the premises are *simultaneous.* The very possibility of symbolizing logical relationships of inclusion by spatial diagrams whose parts are, by their very nature, *juxtaposed,* therefore *simultaneous,* is the reason for this. For there is not a trace of succession in the relationship of inclusion, that is, in the relationship of container and contents. Unquestionably, every conclusion *coexists* in the logical sense with its premises, although it is *thought* and *pronounced* after the premises.

We must not confine our attention to one particular example of the traditional syllogism, for the pre-existence of the conclusion is postulated in every valid reasoning. That is why we say that we *discover* the truth, instead of saying that we *create* it. Just as in the classical syllogism the inclusion of class S in class P coexists with the two inclusions symbolizing the two premises, so in the solving of a mathematical equation,

for example, the "unknown" quantity is *determined in advance* without any ambiguity; thus it is *unknown only to us,* and we discover it in the same way that Columbus discovered America. We say that the solution is simply *waiting for* our discovery, that it exists, so to speak, before our discovery, just as the American continent existed *before* the voyage of Columbus. In the same way, if the future is determined in all its details and without any ambiguity, have we not the right to conclude with Laplace that it is already present and that it is merely waiting to be unveiled to our limited consciousness?

But, if that is true, the same question we have already asked arises again: *Where does the illusion of succession come from?* Why is the future unrolling of universal history not yet unrolled, although it is predetermined in all its details and although the present moment already contains it? If the future history of the universe pre-exists logically in the present, why is it not already here? Why does it require a certain interval of time to become actual, that is, present? Why is there this distance between "it will be" and "it is"? Why does the future require a certain time for its own realization, for its own "becoming present"? Where does this strange time lag come from, a time lag not at all justified by the structure of logical implication, all parts of which are simultaneous? For the average scientist such a question is even more difficult to answer, because for him time is as real as causal necessity; thus he does not permit himself to avoid the difficulty by the traditional expedient of philosophers such as Spinoza, Bradley, McTaggart, and others, who confine succession in the realm of phenomena while excluding it from reality itself.

The incompatibility of causal necessity with the fact of succession was fully emphasized by several French thinkers of the second half of the nineteenth century, such as Jules Lequier, Charles Renouvier, Émile Boutroux, Joseph Delboeuf, and, finally, Henri Bergson. Outside France, it was principally Charles S. Peirce and William James—the latter influenced, at least partially, first by Renouvier and later by Bergson—who insisted on the reality of objective contingency as an essential element of temporal reality. But the intellectual climate of that time was not very favorable to the ideas of this kind. The principle of causality appeared as a simple consequence of the law of conservation of energy (Spencer's law of persistence of force), which in its turn expressed in a new and much more precise way the ancient principle

of the indestructibility of substance. This law was considered a sacred dogma, not only by virtue of the empirical evidence in its favor, but also because it was looked upon as a prolongation, and even as a culmination, of the tendencies which had dominated philosophic thought since its beginnings. It is only quite recently that, under the pressure of the new physical discoveries, we have begun to treat the concept of objective contingency with more tolerance. Nevertheless, in Boutroux's time, and even in Bergson's, necessitarian dogmatism, to use Peirce's expression, continuously strengthened by the triumphs of scientific prediction and by the constantly repeated successes of mathematical deduction in the physical sciences, so fascinated minds that almost no one paid any attention to Bergson when he showed that absolute necessity and real succession cannot be reconciled. In his *Creative Evolution,* in a passage which has become classical, Bergson pointed out that the equations of mechanics are concerned only with the extremities of temporal intervals while the intervals themselves are ignored. Even when we talk about them, we scarcely attach any importance to them:

> Common sense, which is occupied with detached objects, and also science, which considers isolated systems, are concerned only with the ends of the intervals and not with the intervals themselves. Therefore the flow of time might assume an infinite rapidity, the entire past, present, and future of material objects or of isolated systems might be spread out all at once in space without there being anything to change either in the formulae of the scientist or even in the language of common sense. The number t would always stand for the same thing; it would still count the same number of correspondences between the states of the objects or systems and the points of the line, ready drawn, which would be then the "course of time."[14]

Several pages farther on, after having quoted the famous passage from Laplace, Bergson adds:

> In such a doctrine, time is still spoken of: one pronounces the word, but one does not think of the thing. For time is here deprived of efficacy, and if it *does* nothing, it *is* nothing.[15]

Bergson was probably not entirely right when he affirmed that a determinist pronounces the word "time" without thinking of real succession. The state of mind of an average determinist is certainly more

14. *Creative Evolution,* authorized trans. Arthur Mitchell (New York: Henry Holt & Co., 1913), p. 9.

15. *Ibid.*, pp. 38–39.

complex, and it was more accurately analyzed by Bergson in his first book, where he showed that belief in the necessary connection of events consists in the association of two irreconcilable ideas: that of logical necessity which requires the preformation and even the pre-existence of the future, which ceases to be future by the very reason of its pre-existence, and the idea of the temporal process of which the phases are authentically successive.[16] These two ideas are combined in such a close association that they are almost inseparable, and their incompatibility, their very distinction, is, as it were, submerged by the deceptive feeling of familiarity which is only an effect of habit, of prolonged automatization. After Bergson, philosophers should have shown more mistrust in respect to such deceptive feelings of familiarity. No progress can be made in the solution of the problem of causality except by carrying the logical as well as the psychological analysis as far as possible, effecting a separation of the incompatible elements which are fused into the deceptive unity of instinctive belief or of automatized association. Progress can be made only by questioning all the tacit implications, based upon a confusion of the logical evidence with the psychological feeling of familiarity. The revision of scientific concepts proceeds by such an analysis, by what M. Bachelard calls "the psychoanalysis of knowledge." This could be illustrated by a practically limitless number of examples in the history of the sciences. Naturally, such an effort to break the almost unbreakable associations by which the classical scientific tradition was constituted can only be difficult and even painful. That is why we must never be surprised by the constantly renewed resistance which rises in the mind when it is confronted with a profound revision of the classical concepts. It was precisely resistance of this kind which prevented even the most serious and honest minds from perceiving the fundamental incompatibility between real succession and timeless necessity. Quite probably, even Laplace, Du Bois-Reymond, certainly Tolstoi and Anatole France, believed sincerely in the reality of time, although time had no justification in their view of the universe. For them, the question asked by James and by Bergson, "Why is the future, which must be present, still not present?" did not even arise.

16. *Time and Free Will, an Essay on the Immediate Data of Consciousness,* authorized trans. [of *Essai sur les données immédiates de la conscience*] R. L. Pogson (New York: Macmillan Co., 1913), pp. 212–18.

However, in some cases—and they were rare—the determinist philosophers were aware of this difficulty. Thus Hans Driesch, after having affirmed, in spite of his vitalism, his quite Laplacian belief in the integral predetermination of the universe, asked himself the following significant question: Why does the activity of the timeless entelechies manifest itself in time instead of expressing itself by a single, complex act? Why does it manifest itself in the laborious development of the organism from its egg to its adult form? He frankly admits, "For that question, we have no answer."[17]

Such a question is certainly strange, but a consistent determinist is obliged to ask it. More frequently, the incompatibility between real succession and deductive necessity was only vaguely felt, but this vague feeling at least found its expression in certain particularities of language, invented to hide the incompatibility. The difference between cause and effect is too real to be entirely ignored. There is nothing surprising in the fact that the feeling of this difference is not entirely absent, even in the most uncompromising determinist mind. However, as the determinist insists on the absolute equivalence of cause and effect, unwittingly he faces a dilemma of which he is only half-aware. According to what we have said, it is obviously necessary to choose one of two assertions: *either* real succession with the element of real contingency *or* complete determinism with total absence of succession. Since most frequently the deterministic scientist does not see this dilemma clearly, he tries to retain causal necessity alongside temporal succession, but, as these two ideas are incompatible, he succeeds only in veiling with ingenious verbal formulas the conflict which goes on in the depths of his thinking. What is more, this conflict, as we have already said, suppressed by his conscious thought, manifests itself indirectly by certain particularities of his language. William James showed this in a very clear and precise way in his posthumous book:

> *Nemo dat quod non habet* is the real principle from which the causal philosophy flows; and the proposition *causa aequat effectum* practically sums up the whole of it. . . . But if the maxim holds firm that *quidquid est in effectu debet esseprius aliquo modo in causa,* it follows that the next moment can contain nothing genuinely original, and that the novelty that appears to leak into our lives so unremittingly, must be an illusion, ascribable to the shallowness of the perceptual point of view.

Scholasticism always respected common sense, and in this case escaped the frank

17. Driesch, *loc. cit.*, p. 326.

denial of all genuine novelty by the vague qualification "aliquo modo." This allowed the effect also to differ, *aliquo modo,* from its cause. But conceptual necessities have ruled the situation and have ended, as usual, by driving nature and perception to the wall. A cause and its effect are two numerically discrete concepts, and yet in some inscrutable way the former must "produce" the latter. How can it intelligibly do so, save by already hiding the latter in itself?[18]

And in a footnote on the next page James adds:

The cause becomes a reason, the effect a consequence; and since logical consequence follows only from the same to the same, the older vaguer causation-philosophy develops into the sharp rationalistic dogma that cause and effect are two names for one persistent being, and that if the successive moments of the universe be causally connected, no genuine novelty leaks in.

There is no need to emphasize how that which James calls "the sharp rationalistic dogma" agreed with the energetist conception of reality, in which the cause and its effect were only two energy equivalents, the apparent succession of which masked their underlying identity. Thus, as in the monistic idealisms, ultimate and authentic reality is conceived of as permanent and as always identical with itself, whereas succession belongs only to its phenomenal manifestations. To avoid conflict with our immediate consciousness, which remains irremediably temporal, both physical determinism and idealistic determinism invent ingenious formulas. Instead of denying the reality of time outright, one says that time is only "phenomenal"; instead of saying that the effect is entirely identical with its cause, one says that it is "virtually," or *aliquo modo,* present. Through these verbal concessions, it is possible to avoid the truthless conclusion of Parmenides, which by eliminating succession entirely at the same time eliminates even the superficial difference between cause and effect. Let us say it again: if modern determinism, in its scientific as well as in its idealistic form, hesitates to follow the Eleatic School all the way, it is because the incompatibility of rigorous determinism with the reality of time is at least vaguely sensed.

III. WIDENED CAUSALITY

If we admit that absolute necessity is incompatible with the reality of succession, a single conclusion forces itself upon us. We must abandon the classical concept, that is, the Laplacian or Spinozist concept of causality. Such a conclusion frightens many serious thinkers. They are

18. William James, *Some Problems of Philosophy: A Beginning of an Introduction to Philosophy* (New York: Longmans, Green & Co., 1931), pp. 192–93 and n., p. 194.

frightened because they believe that, with the denial of classical determinism, the intelligible character of the world is forever destroyed. For them the denial of classical causality is equivalent to a "capitulation," even to a "suicide," of reason. Similar apprehensions were expressed when non-Euclidean geometry supplanted the classical geometry of Euclid. Naturally, if one looks upon Euclidean geometry as the only possible geometry, such fears would be justified. In that case, and only in that case, the denial of the fifth postulate of Euclid would result in the ruin of all geometric thought. In an analogous way, if Laplacian causality is the only form of rational coherence which the universe may assume, there would be a reason for fearing that, in eliminating it, we might destroy all possibility of rational explanation. The arguments of Herbert Spencer, John Fiske, Hippolyte Taine, and all the other determinists of the last century against free will were inspired by this facile confusion of the two terms "rational" and "determinist." As William James remarked in 1884 in his essay "The Dilemma of Determinism":

> Nevertheless, many persons talk as if the minutest dose of disconnectedness of one part with another, the smallest modicum of independence, the faintest tremor of ambiguity about the future, for example, would ruin everything, and turn this goodly universe into a sort of insane sand-heap or nulliverse, no universe at all.[19]

Then, two pages farther on, James gives some samples of the argumentation by which the determinists try to reveal the fundamentally irrational and even absurd character of their rivals: "A man's murderer may as probably be his best friend as his worst enemy, a mother be as likely to strangle as to suckle her first-born, and all of us be as ready to jump from fourth-story windows as to go out of front doors, etc."[20] In other words, it is believed that, without strict causality, the world is only the domain of the most capricious chance. More recently we have seen the same mistrust on the part of philosophers in reference to the revision of determinism in contemporary physics. René Berthelot, Léon Brunschvicg, and Hans Driesch, to name only a few,[21] have shown

19. William James, "The Dilemma of Determinism," *The Will To Believe,* pp. 154–55.

20. *Ibid.*, p. 157, n. 1. James adds: "Users of this argument should properly be excluded from debate till they learn what the real question is. . . . Persons really tempted often do murder their best friends, mothers do strangle their first-born, people do jump out of fourth-story windows, etc."

21. H. Driesch, "Naturwissenschaft und Philosophie," *Actes du Congrès International de Philosophie, à Prague* (1934); R. Berthelot, *Bulletin de la Société Française de Philosophie,* Vol. XXXIV, No. 5 (October–December, 1934); L. Brunschvicg, *La Physique du vingtième siècle et la philosophie* (Paris, 1936).

their skepticism concerning the objectivist interpretation of uncertainty relationships. As Jean Louis Destouches has asserted,[22] this resistance was inspired by philosophical motives which are not essentially different from those which were found in Spencer, Taine, and Fiske. It is feared that the rational universe may crumble into a shapeless mass of disjoined and capricious facts.

Let us say immediately that such fears are hardly justified because they are based on the gratuitous supposition that the indetermination now being envisaged is a *complete* and, so to speak, *absolute indetermination.* Now this is not at all the case. Absolute indeterminism is a very rare phenomenon, even with philosophers. It can be found in Epicurus and in Lucretius and, in the modern era, in Renouvier, at least in a certain phase of his philosophy when he was defending the notion of "absolute beginning." But, if we read carefully the works of those who defend the indetermination of the universe in the name of the reality of time, we see that their indeterminism is far from being absolute. The temporalistic philosophers, or, as they are called in English-speaking countries, the "process-philosophers," insist vigorously on the continuity of the past with the present, on the cohesion of the successive phases of becoming. Reread the passages of William James on the stream of consciousness or on the continuity of the perceptual flux; reread Bergson, especially that passage, so infrequently quoted, in *Matter and Memory,* where he affirms that creation is never *creatio ex nihilo* because each present moment is colored by its past; reread Whitehead when he speaks of "causal efficacy" in nature.[23] What, then, is the difference which separates them from the classical determinists? There is only one: when they speak of connection, of continuity, of cohesion of cause and of effect, they affirm that this connection, this continuity, this cohesion, is *temporal* in the true sense of the word, and as such it cannot be the equivalent of static connection, of logical implication; consequently, that it must contain an element of *irreducible novelty,* an *authentic differentiation between cause and effect,* a differentiation which has in it nothing irrational and nothing miraculous because it expresses the distance between the present and

22. Jean-Louis Destouches, *La Physique moderne et la philosophie* (Paris, 1939), pp. 39–40.

23. A. N. Whitehead, *Process and Reality* (Cambridge: Cambridge University Press, 1929), *passim.*

the anterior moment. Briefly, if we venture to use a formula which is perhaps too condensed, we can say that for a modern contingentist time *truly flows* and that the partial indetermination of each temporal moment is only a manifestation of this real flow, whereas, for the classical determinists, time flows, according to Bergson's expression, only because reality demands this sacrifice, "taking advantage of an inadvertence in their logic."[24] We can also say that, for modern contingentism, the *future remains* future, that is, virtual by its own nature, whereas for Spinoza, Laplace, and the others, the future is only a *hidden present.*

In recognizing the virtual character of the future, modern contingentism admits the category of *possibility* which, according to classical determinism, possesses no objective character, being only a manifestation of our ignorance. For Spinoza, for Hegel, and for Laplace, the *real* and the *necessary* are two *synonymous expressions*—for that which is not real is impossible. Consequently, there is no middle ground between the necessary and the impossible. That is why the future, being necessary, must be, for a consistent determinist, *as actual as the present* and as completed as the past. The unlikely and even absurd character of such a consequence has already been fully exposed by Émile Boutroux:

> Is it to be admitted that all possibles are, in their essence, eternally actual; that the present is made up of the past and is big with the future; that the future, instead of being contingent, already exists in the mind of the one supreme purpose or understanding; and that the distinction between being and the possible is but an illusion caused by the interposition of time between our point of view and things in themselves?
>
> This doctrine is not only unwarranted and impossible of proof, it is also unintelligible. To say that each thing is actually all it is capable of being is to say that it unites and reconciles, within itself, contraries, which, from the knowledge we have of them, can exist only by replacing one another. But how can we conceive of these essences as formed of elements that are mutually exclusive?[25]

The logical force of this passage was recognized, at least implicitly, even by Alfred Fouillée, who has always remained a staunch adversary of contingentism. It was probably under the influence of the passage we have just quoted that Fouillée wrote in his critique of contingentism:

24. H. Bergson, *The Creative Mind,* trans. [of *La Pensée et le mouvant*] Mabelle Andison (New York: Philosophical Library, 1946), p. 220.

25. É. Boutroux, *The Contingency of the Laws of Nature,* trans. F. Rothwell (Chicago: Open Court Publishing Co., 1920), pp. 21–22.

> We live in time and we reason in time. Now in time it is *contradictory* to say that the future exists and acts, since, in that case, I am at once living and dead, really living and really dead, my future death being already real, as is my present life. Such a theory means the elimination of all possible thought and of all possible experience, since thought cannot admit the simultaneous actuality of contradictories, and since experience cannot grasp the present and the future simultaneously.[26]

It is obvious that here Fouillée sought to answer the question which the contingentists always ask: "If the future is certain in all details, why is it not already present?" To this question Fouillée answers: "It is the incompatibility of the successive events which prevents the future from being contemporaneous with the present." Succession is thus only a consequence of the law of contradiction. Moreover, the same idea had already been expressed by Leibniz when he defined time as "the order of inconsistent possibilities."[27] But neither Leibniz nor Fouillée was aware that, by such a concession, they were indeed undermining the ground on which their determinism had been built. For the fundamental incompatibility of the successive phases, which they admitted, is precisely *completely contrary to the connection of logical necessity* which, *according to them, joins the successive events.* One of two propositions must hold here: *either* the successive phases of each temporal process are mutually deducible, *or* they are logically incompatible. But it is clear that they cannot be at the same time mutually derivable and incompatible. This impossibility is only another aspect of the fundamental incompatibility of strict determination and real succession.

The fear that the elimination of rigorous causality may destroy all intelligibility of the universe is, let us say again, childish. On the contrary, it is contingentism which makes causality—or rather let us say *causation* (reserving the term "causality" for Laplacian causality)—more intelligible. We have seen that rigorous determinism virtually destroys the temporal character of reality as well as all the difference between cause and effect. But have we not then the right to wonder, along with Boutroux: *"Would this also be a consequent, an effect, a change, if it differed from its antecedent neither in quantity nor in quality?"*[28] By re-establishing the temporal character of causation, we escape the bizarre paradoxes of necessitarian determinism of which the deter-

26. Alfred Fouillée, *La Pensée et les nouvelles écoes anti-intellectualistes* (Paris: Alcan, 1911), p. 140.

27. G. W. Leibniz, *Phil. Schriften*, I, 568.

28. Boutroux, *op. cit.*, p. 29.

minists themselves were often unaware. But in thus restoring the real difference between cause and effect, we are conceding the reality of contingency, or at least of the element of contingency; for the difference between the successive phases of becoming is only another name for the element of contingency, of unpredictability, of radical novelty, which is the very essence of temporal causation.

Let us stress the fact that it is this notion of widened causation which contemporary physicists—or at least most contemporary physicists—are tending to adopt under the impact of recent discoveries. The concept of objective possibility, which was always looked upon as legitimate by the contingentists, comes into the field of science in the form of the concept of *objective probability*. For the classical physicists the concept of probability was only a useful conceptual tool which could be used when the physical events were too complex to be analyzed in detail. However, nothing objective corresponded to this conceptual fiction despite its practical utility. Such an attitude was entirely logical. If there are no real possibilities, there are no real probabilities, either; for, as the German physicist, Weizsäcker, quite recently observed, the concept of probability is only the quantitative form of the concept of possibility. The contingentists were always opposed to this subjectivist interpretation. Let us remember Cournot, let us remember Renouvier, when he insisted in his *Essai de logique générale* that "the equal possibles of Laplace are to be understood in the final analysis as truly indetermined possibles in themselves, as possibles which are rigorously ambiguous." Let us remember James, when he had the courage to maintain as early as 1884 that *"somewhere,* indeterminism says, such possibilities exist, and form a part of truth."[29] Bergson's attitude seemed more ambiguous because he resolutely denied the pre-existence of the future in any form, even in the form of possibility. That is at least the thesis defended in the first two essays of his book, *The Creative Mind* [*La Pensée et le mouvant*]; but, on the other hand, we have to reread pages 204–12 of *Time and Free Will,* in which Bergson, while rejecting the mathematical preformation of the future in the present, still affirms that there is a preformation of another sort, which constitutes our consciousness of time—this is the preformation of the future "in the form of pure possible." Thus we see that the category of the possible has its place in Bergson's thought, which is not surprising, for the

29. O. Hamelin, *Le Système de Renouvier* (Paris: J. Vrin, 1927), p. 147; William James, "The Dilemma of Determinism," *The Will To Believe,* p. 151.

complete elimination of this category is found only in the defenders of integral necessity. Space does not permit us to discuss here the precise meaning of the Bergsonian views on possibility, which, in appearance, were seemingly contradictory. The reader should consult the final chapter of M. Jankélévitch's book on Bergson. On this point, the French and American contingentists anticipated the tendencies of contemporary physics or at least the objective interpretations of uncertainty relationships. Although Reichenbach recently proposed to replace strict causality by probable implication, he was scarcely aware that such a probabilistic interpretation of uncertainty relationships agreed with the conclusions of Cournot, Renouvier, Boutroux, James, Bergson, Peirce, and, more recently, Whitehead. At the same time we see why contingentism can be called a *relative determinism:* the future *is* determined, but only in its general character, never in its actual details. It is this general orientation of each present moment that contemporary physics grasps in the form of probabilistic laws.

In the light of quantum physics we can today answer the objection which Ralph Barton Perry raised against the Bergsonian affirmation of the incompatibility between rigorous necessity and the reality of time. It will be remembered that, according to Professor Perry, the simple fact of mechanical motion establishes irrefutably the compatibility of time with rigorous necessity: a material particle, whose trajectory is entirely determined by the laws of mechanics, nevertheless *moves,* that is, it occupies diverse positions in space *in successive moments.* But this example is obviously borrowed from macroscopic (i.e., from classical) physics. Its plausibility and its apparent clarity are completely deceptive in the light of recent physics. The predictability of the positions of any given macrophysical particle—and we observe only macrophysical particles—is only *approximate* and, as such, remains entirely compatible with the fundamental contingency of underlying microphysical events. The predicted trajectory of a particle, which, in our macrophysical perspective, appears as a precise geometric curve with no transverse thickness, is, in reality, a *thin tube,* a *bundle of possible routes,* which, although very thin, still has transversed dimensions corresponding to the quantic indeterminations of the future positions.[30]

30. See my articles: "The Doctrine of Necessity Re-examined," *Review of Metaphysics,* V, No. 5 (1951), 40–45; "Relativity and the Status of Space," *ibid.,* Vol. IX, No. 2 (1955); and "La Théorie bergsonienne de la matière et la physique moderne," *Revue Philosophique,* Vol. LXXVII (1953).

Thus even in the example considered by Professor Perry, the so-called route of the future is far from being "the only possible route," because it is composed in reality *of the entire field of the possibilities,* which, although very close to each other, still remain distinct. In other words, it is only by virtue of our macroscopic myopia that the field of the diverse possibilities seems to shrink so that it appears finally as a precise infinitely thin line of "the only possible route." There is no need to emphasize that such expressions as "the only possible future route" and "the necessary route of the future" are completely equivalent; classical determinism, by eliminating all the future possibilities save one, in fact eliminated the category of possibility, which was thus reduced to a human and temporary ignorance. In the light of recent physics such an elimination of the concept of possibility is no longer legitimate, although we understand how the character of the macroscopic world, as well as the limitations of our perception, made it inevitable before the time of quantum physics. Nor is there any need to emphasize that the concept of a solid and permanent particle is no longer adequate on the microphysical scale, since solidity itself is only an illusion—a necessary illusion, it is true—of our gross perception. The microscopic reality seems to be composed of *events* rather than of *things.* We may wonder to what extent the Eleatic and atomistic habits of our thinking have been determined by this "logic of solids," which, according to Bergson and Bachelard, is a subconscious foundation of the classical intelligence and which is virtually outlined in the very structure of our macroscopic perception. This is the question which the modern followers of Parmenides and Democritus do not ask themselves.

Not only quantum physics but also relativistic physics confirm the temporal, therefore contingentist, conception of reality. Such an affirmation may appear surprising because it is opposed to the rather widespread presumption according to which the fusion of time with space in the theory of relativity operates in favor of space and that the space-time of Minkowski is a static entity in which the alleged successive phases of cosmic history coexist in their eternal juxtaposition. We do not have space here for a detailed critical analysis of this singular misunderstanding, to which Minkowski himself contributed. Let us merely remember the numerous criticisms made of this erroneous interpretation, from Langevin to Eddington and to Meyerson. Quite justifiably, we can affirm that the fusion of space with time operates, contrary to the easy popular notions, in favor of time and that, instead of the

spatialization of time we have rather a temporalization, or at least a dynamization, of space.[31] Let us simply recall the fundamental principle of relativistic dynamics according to which there is an upper limit to the transmission of any causal action: this is the speed of the electromagnetic waves. This is, as Paul Langevin said, the speed limit of causality. Thus there are no instantaneous transmissions in nature; there are only successive connections. In other terms, the theory of relativity has boldly stressed the idea that *the effect is never contemporaneous with its cause* and that causation is always irremediably, and by its very nature, successive. We have already seen that the reality of contingency inevitably follows from the successive character of causation. One may raise an objection by pointing out that contingency is not at all introduced into the theory of relativity. But that is due to the *macrophysical* character of the theory—the microphysical indetermination is, so to speak, masked by the laws of the big numbers on the macrophysical scale, and that is why it has been discovered only on the microphysical scale. But we must not be deceived here: the dynamic and unfinished character of physical reality is as present on the macrophysical scale as it is in the microcosm.

If real novelties exist even in the physical world, there is nothing surprising about finding them in the area of life and of consciousness. Moreover, almost all the objections which have been raised against indetermination on the biological and psychological scale have been inspired by dogmatic belief in physical determinism. It is obvious that the widening of the notion of causality creates a novel situation for the problem of freedom. All the contingentists were aware of it, although they have confused microphysical indetermination with the freedom of living beings. But the discussion of the very complex problem of relationships between contingency and freedom would lie outside the scope of this article.

31. Louis de Broglie, "L'Espace et le temps dans la physique quantique," *Revue de métaphysique et de morale*, LIV (1949), 119–20.