

Contemporary Thomists who oppose the very idea of objective indeterminism as it is maintained by the new generation of scientists seem to be in complete agreement with Suarez who holds that an effect "which is contingent with respect to the proximate cause operating naturally, if compared to the whole order and series of the causes of the universe, no free agent intervening, at least as applying other causes or removing impediments, has not contingency but necessity."¹ If this were the case, every science of nature that would have a finite understanding knowing sufficiently the initial constellation of the universe would be a hypothetico-deductive science and as absolutely rigorous as mathematics until the arrival of one who, on the speck of sand that he inhabits, would be able to introduce by his free will unforeseeable determinations. From the origin of the world and until the intervention of free agents, everything would be given once for all, and the future would await only a lazy existential determination. We say that every science would be *hypothetico-deductive*, if one admits that the initial constellation could be other than in fact it had been and in this it would be comparable to mathematical postulates; but once such a constellation is given, everything would follow rigorously until the arrival of the disturbing gentleman.

Since Suarez is obliged on this point to contradict Aristotle, and since this position results logically from principles most absolutely contrary to those of Thomism, one ought at least ask whether we should make this concession. For Suarez, the phenomena of chance (by opposition to those of fortune) are not *future contingents*² but future necessities, coming predetermined from the causes of the universe and foreseeable. Natural contingency would be only extrinsic and *secundum quid*. "Prima autem causa, sive Deus, solum dici potest prima radix hujus contingentiae, sicut est prima causa omnium effectuum universis; quia nimirum tales causae secundae ab ipsa fuerunt et creatae et ita dispositae et ordinatae, ut ab eis hujusmodi effectus contingentes provenirent. Ad hoc autem, formaliter loquendo, nil refert, quod prima causa libere haec omnia produxerit; eadem enim contingentia sequetur etiam si ex necessitate creasset haec omnia dummodo eodem modo illa ordinasset, et postea cum illis concurreret."³ I do not see how this extrinsicist

conception of contingency can be reconciled with that of St. Thomas who attributes every chance phenomenon as such to an intrinsic cause *eorum quae sunt a casu causa est intrinseca sicut eorum quae sunt a natura*, which is how chance differs from fortune whose cause is extrinsic.

The solution of this purely ontological problem cannot be applied just as such to the problem of indeterminism in the experimental sciences. This is what I will try to show in the second section of this essay, where we will adopt the viewpoint of the philosophy of science. These reflections provide only 'approaches'—scattered and often quite indeterminate—which could contribute to a systematic and in-depth study of the problem. I hope moreover to show that the unbridgeable chasm that separates the Thomist school from schools of Suarezian inspiration involves not only the summits of creation, free agents, but also the unforeseeable leaps of electrons.

Positive and Negative Indetermination. Let us distinguish at the outset two completely different species of indetermination. The freedom of God with respect to the finite is a necessary consequence of His absolute necessity. In other words, absolute determination is the root of a positive indetermination which is essentially perfection. Only in God do we find fully realized the determinist ideal. But at the same time, nothing could more disappoint the determinist, since this pure actuality grounds the possibility of the finite and the liberty God has to bring it into being.

Every finite being participates in this indetermination by perfection, according to the degree of indetermination of its essence. The essential determination of the higher angels is the root of superior intelligence and consequently of greater liberty. As the intellection of the angels becomes more and more complex, there is a proportional positive decrease.⁴ And just as there can be cognition that is not intelligence, so there can be positive indetermination without liberty. The plant and animal participate in this positive indetermination in their spontaneity and to the degree that their behavior involves unforeseeability. No doubt there is no spontaneity in the inorganic world, considered as such. But to consider the inorganic world 'in itself' is to make a partial abstraction, for it is not a whole closed on itself like the living. Speaking ontologically, there is no inorganic world 'as such' in the way that there are plants and animals 'as such' because the active principle 'quod' is totally exterior to it. But at the same time, without this principle, which is at least living—by which the non-living participates in spontaneity—the inorganic world is contradictory.

Thus there is a constant relation between the degree of essential determination and the degree of positive indetermination. In the finite order, this indetermination is always of an accidental order. Even in living things this indetermination by increase is the root of an uncertain future, of future contingents. Otherwise, it could not be known if they act, and if the active principle of their movement is truly theirs, at least in part, according to their degree of perfection; it would be impossible to distinguish a robot from a living thing; there would be no essential difference between two stags confronting one another and two toy soldiers that collide. In fact, setting aside greater complexity, their behavior would be absolutely the same—whether the active principle were extrinsic or intrinsic—and Descartes would have been perfectly right.

But in every finite creature there is also found another kind of indetermination, this one negative, which is essentially imperfection. To the liberty that God has to cause the finite to exist there answers in the finite an indetermination due to defect of being: it can be or not be. The existing essence cannot be its existential determination. The contingent is necessary when it exists, but it does not derive this necessity from its present condition; that comes from the one who gives it existence. In its present necessary condition, it is also necessarily of a contingent nature. *Ipsa natura vel quidditas est possibilis respectu esse quod a Deo habet*. And in this sense it can have contingency within necessity, on condition that we are talking of the present, not the future.

So all finite beings are equally contingent insofar as they are finite, compared to one another, some are less so than others, according to the perfection of the essence which receives more or less intimately the proportioned existence. In this perspective, the lower angels are more contingent than the higher, man less contingent than the brute, and so on.

What pure spirits have that is quite specific by opposition to cosmic beings is simplicity and perfect determination of essence. Hence the simplicity of their non-successive and invariable substantial duration: 'The essence is given in its entirety once and for all. It has no past or future. There is on the other hand something irreducibly obscure in the composed angelic substance, because its essence is not its existential determination. This obscurity is proportional to the imperfection of the essence. From this point of view, one can say that one angelic essence is less determined than another even when there is no indetermination in the essence considered in itself. There is contingency here only in the relation of essence to existence.

Let us consider for a moment the direction of degradation in this hierarchy of the angelic universe, each of whom constitutes in itself a complete species subsisting outside any natural common genus. To provide a direction to this perspective, it is important to note that if this hierarchy cannot have an ultimate higher possible limit there is however a lowest possible limit (as in the analogous case of the series of whole numbers) that could not be surpassed without entering into a new order of essences generically different. More precisely, an order of essences sharing in the same physical genus. Looked at in the direction of this lower limit, we observe in the spiritual hierarchy itself the prefiguration of a new species of negative indetermination. The essences, always simple, are less and less one, less and less determined. There is as it were a tendency to disintegration of the essence, toward a real and intra-essential indetermination. The substantial duration of pure spirit is less and less intense. The present tends to disintegrate. This degradation of spiritual durations prefigures the existence of the physical and composed essence; it prefigures the successive and continuous duration that is time properly speaking. In other words, it prefigures the true future. The intuition of the essence in the angels is impoverished according to the imperfection of the essence and understanding; in order to know other beings, it has need of more and more numerous ideas, its activity is more and more fragmented; the discrete duration constituted by the continuous suite of thoughts and acts of will is more and more dispersed, there is, so to say, more and more of a future. The angels are more and more removed from themselves and from what is outside themselves. All this prefigures an intelligence turned outside itself, a blank slate, and which will have need of the passive experience of the subject. To the degree that the perfection of the pure spirits diminishes, their heterogeneity is attenuated, they resemble one another more and more: they give an intimation in this way of a plurality of individuals of the same species and quantitative and spatial homogeneity.

This perspective reveals in the angelic hierarchy a prefiguration of the cosmos, analogous to that of the circle toward which the inscribed polygon whose sides are multiplied tends. Whichever of the points of view just suggested be chosen—that of essence, that of duration, of understanding, of individuation—it enables us to foresee matter, pure negative indetermination. It is by this that the individuation of non-substant forms is explained, passive experience, time, space, etc. But it also entails a new species of con-

tingency unknown in the spiritual universes, which is proper to the nature which results from the hylomorphic composition of essences.

Contingency in Nature. This problem is very intimately linked to that of duration. What is it in fact that impedes cosmic essences from being given all at once and to endure without succession if not the indetermination of matter? It is not only the complexity of the essence which entails as well a certain complexity of existence. One of the principles of the essence must be pure indetermination, without which the essence could not be an "unum per se." This indetermination is not only the root of a duration which flows, but to the degree that it is in play, it makes a totally assured existence impossible: it is the cause of the uncertainty of becoming. This uncertainty does not have absolutely precise conditions, since it arises from a real indetermination. We find ourselves confronted here by a contingency in the very interior of duration that one does not find in the pure spirits which have no substantial becoming and whose existence is assured in the identity of an eternal present. *In perpetuis non differt esse et posse.*

Natural beings are busy in the pursuit of existence, and lose time in doing so. But the pursuit of an always remote existence cannot be the ultimate end. This diffusion of time must be progressively arrested by the guidative perfection of the world. From this point of view, our universe is a tendency toward a duration ever more simple, ever less diffuse, finally terminating in the spiritual form of man, whose existence, abstracting from the matter of the composite, is eternal. In his present state, man already realizes this aspiration of the world, but in a provisory way, since he is always in part corruptible.

What prevents this ultimate and intrinsic end of the cosmos from being realized from the beginning? From the beginning, matter is essentially ordered to man, to this intelligence that has need of passive experience, therefore of sensation and animality which entail vegetative life and corporeity; it is in the human species which by the possibilities of matter compensates for the defect of unity in the multiplication of individuals. If matter does not have this act right away this is because originally it is not sufficiently disposed and first much must be done, a work which consists in eliciting ever more simple quidditative determinations. The cause of this resistance of the world is nothing other than the indetermination of matter.

Still, it is impossible that the entire future should be really predetermined in the past or present state of the universe. If it were, since matter is something real and not a pure logical possibility, the future would already exist; everything really possible in matter would exist simultaneously and eternally; the pure potentiality of matter would be wholly deprived of any real meaning. And if the future is not predetermined in the present, then there is uncertainty, the future contingent.

If the term of this cosmic ascension (the human species) is very certain, without which matter would be really contradictory, the ways that lead there cannot be absolutely predetermined, otherwise matter would be determined in advance to all the forms which in fact lead to this term. So we must see in matter cause both of certitude and incertitude. Hence the absolutely irreducible role of contingency in the maturation of the world.

This contingency touches even the structure of natural forms which cannot be entirely determined "ad unum" like the angelic form. It is just this lack of determination and incapability of individuating itself that calls for matter. This need for matter introduces into the form itself an irreducible obscurity. One cannot have a distinct idea of a cosmic form independent of the idea of the composite.⁵ And the matter which enters into this idea is not determined without signifying as well its determinability with respect to an infinity of other forms. A non-subsisting form is not a quiddity in the strict sense.⁶ That means that the different (I do not say diverse) natural forms cannot be absolutely opposed as are those of pure spirits, because their definition includes the notion of matter, that is, the possibility of an infinity of other forms which can be extracted from this matter, so much so that the existing varieties are analogous to the segments of a continuum determined *a posteriori*.⁷ In this sense they are contingent, always *quidditative* *new*. Between any two given natural forms there is an indefinite possibility of other forms. These forms are purely potentially in matter and consequently the determination that any material form is must come to be *insofar as it is determination*. One must keep to this language in order to avoid any *latitatio formarum*. Too often the birth of natural compounds is thought of as the release of already given determinations.

The different natural forms are not contingent in all respects however. This contingency affects only the sub-species, but, since the infra-human natural species are only realized in sub-species, one can see the range of this contingency.

Let us suppose, in order to illustrate this idea, a finite intelligence contemplating the universe at a moment when it contains no actual living thing. This intelligence would be able to foresee with infallibility the coming of man into the world and also everything that conditions absolutely the determination of matter in view of the human composite: it would foresee the plant, the brute, but it would be impossible for it to foresee all the concrete ways in which natural species are realized. These species, which are *quasi-genera* with respect to sub-species, are apriori certain because they constitute irreducible degrees of being: there is no intermediary between 'being,' 'living,' 'knowing,' and 'understanding.' The absolute character of this gradation moreover has its ground in the idea of man whose soul is formally sensitive, vegetative, and the form of corporeity. Because man's soul is all that, not only eminently but formally, these degrees of being are susceptible of being directly realized outside him. The inorganic, the plant and animal are certain limit-species. But it is impossible that the proper determination of the sub-species which realizes in a particular manner these natural species should participate in this certitude. If it did, the ways in which the animal or plant can be realized would be determined in advance in matter; or again, the matter included in the idea of man would explicitly signify all possible forms: that is, that matter would not only be an idea, but determinate ideas.

The intelligence we have imagined would know with certainty that matter will receive the human form, but the same could not be said of intermediate forms. The multitude of possible sub-species is indefinite—between the highest of vegetative forms and the lowest of given animal forms there is still an indefinite number—and consequently it involves what is not compossible. If one wants to progress, one would have to span the intermediate forms, each leap constituting a clear rupture with an actual intermediary. No doubt the structure of the scale will be to a certain degree determined by the material given at the outset and by the end. But the number and distance of degrees could not be given in advance. The number of steps it takes to travel a road does not depend exclusively on the length of one's legs but also on the quality of the road. The surprises matter has for us are indefinite. One could not see in the initial composite (or composites) a rigorous plan of the hierarchy to be established, as if the universe were a multiplication table, or matter a subject which receives forms coming from without, as the Platonists would have it.

There is then the unforeseeable in the order of *natural determinations*: all sub-species were at one moment of the existence of the world future contingents. The hierarchy of these species is irreversible. So one can see why the sub-species 'cow' as cow is philosophically indefinable. It has determinate truth only *a posteriori*, like the actual cuts of a continuum. (The Flemish proverb "True as a cow" to designate a truth at once evident and obscure is to the point.) The problem of contingency in nature is not limited to that of chance and fortune, even if these two forms of contingency are the most evident.⁸

The fixity of sub-human forms is thus only a counterfeit fixity. We are naturally metaphysicians: hence the need to see the necessary and to liken in this instance the cosmic hierarchy to the series of whole numbers or to the immobile hierarchy of pure spirits, when there is only an analogy between them. If we are manifestly metaphysicians in our search for the necessary and the purely intelligible, we deceive ourselves and we reveal ourselves as understanding when we think it is everywhere realized. And it is precisely in an era of metaphysical sterility that physical determinism was born.

To say that all the sub-species are contingent in their very structure is not to say that they all are so in the same fashion. A natural form is determined "ad unum" according to its degree of perfection, to the degree that it responds to the appetite matter is. The greater a determination, the more unique it is. The pure spirit, whose essence is totally determined, is absolutely unique as a species and as an individual. Material forms approach necessity to the degree that they emerge from matter. Nature tends toward essential necessity as it tends toward an ever greater positive indetermination, which is realized in the highest degree in human freedom. The more one ascends the natural hierarchy, the less contingent in their structure are forms, the more heterogeneous. Of all cosmic species only man cannot have sub-species, just because his form is spiritual, and in that the immobile determination toward which nature tends is realized. Moreover, even here, determination attains only the species and not the multitude of extremely various individuals through which the defect of determination due to matter is compensated.

The path that leads nature to its term becomes more and more straight, and when one considers the situation of the lineage of anthropoids one observes that the departures from the principal current are more and more easy and profound: the possibilities lessen because of the extreme determination required for man.

It is for experimental science to tell us how this world of "fluxibilia" is fashioned. This role devolves on experimental science precisely because one could not make of this domain rigorous deductions in function of the necessary. By its research it tries first of all to reconstitute the concrete path or paths which nature has in fact followed. But it also tries—and this is its principal role as 'science'—to find the essential limits within which the world should progress in order to arrive at man. Between these limits there is play. It is precisely this orientation of nature, very determined with respect to the final end, relatively undetermined with respect to the prior developments, which grounds the possibility of a science in this domain.

Let us now place ourselves in the point of view of nature taken in the strict sense of "principium et causa motus et quietis ejus in quo est primo et per se et non secundum accidens."

Natura determinata est ad unum. This is a principle that is ceaselessly abused. Habitually one fashions too homogeneous an idea of nature, as if all natures were equally natures. Ought one not rather say that there is nature only to the degree that matter and form are determined? If the form had perfect determination of itself, it would no longer be nature. Notice that not only is form called nature but also the matter of the composite. In beings where form alone is principle of activity, the form is not called a nature nor its activity movement.⁹

If natural beings form a hierarchy according to the degree of determination of their forms, they constitute a hierarchy of natures. There will be a gradation in the order of activity: effects will not be lawfully determined in their cause only to the degree of the perfection of nature. And if they are perfectly determined in their causes, neither the causes nor their effects will be natural. Taking into account the important distinction between indetermination by defect of being and indetermination by excess, it appears that in a higher nature the effect will be more assured in the cause and at the same time that the emanation will have less necessity, either because of spontaneity or because of freedom. The certitude grounded in the determination of nature is matched by an incertitude due to the very perfection of the cause.

Regarded under the aspect of negative indetermination, every future natural effect can be uncertain, not only because it cannot respond to the inclination of nature but also because none of the *intended* effects is sufficiently predetermined in its cause. Each future effect, taken individually, involves uncertainty. Only an absolutely determined cause can exclude the contingency

of the future. It is false to think that in a natural cause certain effects are perfectly determined to be, others predetermined not to be or not to respond to the intention of nature. This is due to forgetting that matter is potency and that it is precisely its indetermination which is the cause of uncertainty, and that matter enters into play in every natural causation. "Est autem unumquodque contingens ex parte materiae: quia contingens est quod potest esse et non esse; potentia autem pertinet ad materiam. Necessitas autem consequitur rationem formae: quia ea quae consequuntur ad formam, ex necessitate insunt. Materia autem est individuationis principium. . . ."10 But matter can be the cause of contingency only because there is a defect of determination even on the side of the agent cause. "Unde dicendum est quod possibilitas materiae ad utrumque, si communiter loquamur, non est sufficiens ratio contingentiae, nisi etiam addatur ex parte potentiae activae quod non sit omnino determinata ad unum; alioquin si ita sit determinata ad unum quod impediri non potest, consequens est quod ex necessitate reducat in actum potentiam passivam eodem modo."¹¹ There is play in the very interior of the determination of nature, to the degree that this can be entirely determined ad unum. The absence of necessity in the form entails an absence of necessity in the effects. "Quoniam entia necessaria, ut sic, abstrahunt ab omni tempore et mutatione, cum sint impossibilia alter se habere: ac per hoc, cum ista sint consequentia materiam necessaria, quanto magis appropriantur ad materiam, tanto minus sint necessaria. Entia vero contingentia e converso se habent."¹² Taking into account this idea in the order of activity, it is evident that every natural generation involves uncertainty. If uncertainty were entirely eliminated, this would be because the form is entirely determined. But then generation itself would become impossible.

As in the case of form, this uncertainty affects the very structure of the effect and not only its existence. A child is not said to be defective because he is not a perfect reproduction of its parents. It can be particularly successful because he is different, which does not prevent its being a natural effect. Uncertainty does not suppress nature, it is the elimination of all uncertainty that suppresses nature.

If each nature taken individually always implies a certain dose of indetermination, how could the ensemble of natures totally compensate for this defect?¹³ The whole of the universe does not permit us to abstract from the consequences of matter, as Vasquez did, or to a purely extrinsicist conception

of the contingency in nature, with Suarez, who follows very close the Stoics of whom Thomas said, "dixerunt haec (possible et necessarium) secundum exteriora prohibentia."¹⁴ One can also see what are the effects of so profound a divergence from the doctrine concerning the principle of individuation.

To substitute for the uncertainty entailed by individual natures a necessity due to the ensemble is to deny the individual nature which is the intrinsic principle of movement. Even by adopting the surpassed hypothesis according to which the movement of the heavenly bodies was taken to be necessary, the works of lower nature would not have been: on the one hand, this movement communicated to lower agents, even if in itself necessary, was received according to the mode of the lower agents whose form is not wholly determined; on the other hand, the effect does not relate directly to the necessary cause, but mediately to the lower agent of which it bears the mark. That is, in causation one must take into account the non-subjected (*non-soumise*) matter.¹⁵

No doubt it does not suffice to consider an effect exclusively in its relation to the proximate cause to determine whether it is absolutely natural or not. It is the intention of universal nature which is primary and principal, and in this perspective the corruption of individuals and species is natural. But the birth of new species is also natural, although they are superior to the natures that precede them. It is not a matter of considering the particular end of individual agents or species, since these can be essentially ordered to something else and make sense only in the perspective of the universal order. Thus, the reproduction of similar individuals cannot be the final end of infra-human species, since this multiplication shades off into an unrealizable indefinite. Something else more perfect must result. Moreover, here below, every generation is essentially provisory. (This is what fixists forget when they attribute to natural generation properties which belong to generation only in God.) Lower natures are a function of universal nature even in generation. Still, when a higher nature is elicited from the potency of a lower nature by equivocal generation, this eliciting is still natural, not with reference, no doubt, to the lower agent considered in itself as lower—*generatio est origo viventis a vivente in similitudine naturae*—but it is always natural in the degree that it responds to the desire of the lower nature as ordered to the good of universal nature and to the ultimate intrinsic end of the world. And if the constitution of the hierarchy of cosmic

species is an "opus naturae," the irregularity of this scale, as shown to us by experimental science, is perfectly explained.

Therefore there could only be perfect necessity in the works of nature if abstraction were made from matter—at once the principle of individuation and of contingency—which enters into every work of nature and without which nature is not nature. And when we speak of hypothetically necessary laws, we mean to say that an effect is certain to the degree that the form dominates matter. In other words, the laws of nature would be necessary if matter were neither nature nor the principle of contingency, if in the work of nature form alone were nature. The expression "hypothetically necessary" is therefore subject to a caution. It applies in no way to future contingents save in their relation to the divine intelligence and will.

Natural causes attain their effects in the majority of cases. But this must be understood. We say that the majority of human generations are successful, since the majority of men are also normal. But the majority of men are also mediocre. Yet mediocrity cannot be the intention of nature. In what sense can it be said that men are *naturally* mediocre? Because it is quite natural that mediocre generators produce mediocre children. What is astonishing is that they sometimes produce superior men. Moreover, it is the wise who are *de primaria intentione naturae*, and in this regard, the majority of men are nature's gaffs. It does not suffice then to consider an effect in its relation to the ultimate end in order to determine whether or not it is natural. For in this perspective, nature succeeds only exceptionally and this can be more natural than the *ut in pluribus*. It is not sufficient that a thing be exceptional and unforeseeable in order that it be due to chance. There is chance only when it is in the intention neither of the proximate cause nor in the intention of universal nature, because as long as it remains in these two orders, there are more or less determinate causes. Chance is an entirely undetermined cause.

The Accidental Causality of Nature

Consider a dog killed by the fall of a tree. We say that its accidental death is due to chance. What allows us to say this? Wasn't the tree determined to rot and fall with such and such a speed? And was not the dog pursuing such and such a cat that had hidden in the tree? Is it not natural for a dog to

chase a cat and, being mortal, to be killed by such a weight? All that can be perfectly determined, therefore foreseeable. But if chance is the cause of essentially unforeseeable future contingents, how can we attribute this coincidence to chance?

Whatever the number and remoteness of the factors which enter into play in the phenomenon, it is absolutely certain that it was unforeseeable in its proper cause. One cannot deny it without denying nature. Let us interpret this example in the light of the fundamental principles of the theory of chance of Aristotle and St. Thomas.

a) *Virtus naturae se habet ad unum; quod autem est per accidens non est unum.*¹⁶ The proposition, "the fall of a tree killed a dog" has only an accidental unity: there is no essential connection between the fall of a tree and the death of a dog. Otherwise, a tree could not fall without killing a dog, and the dog could only die by being crushed by a tree. But a natural cause is one and determinate. Therefore, such an effect can only have an indeterminate cause.

b) *Id quod est ut in pluribus est causa entis per accidens.* "Ens ut in pluribus est causa et principium quod aliquid sit per accidens. In rebus enim quae sunt semper, non potest esse aliquid per accidens; quia solum quod est per se potest esse necessarium et sempiternum. . . . Unde relinquatur, quod solum in contingentibus potest esse per accidens."¹⁷ It is the insufficient determination of nature that makes possible events which exceed the very limits of nature, limits within which there is play. So much so that the contingency proper to chance presupposes a contingency, a *mutabilitas* in the natural cause. Whatever the perfection of the form, there always remains a margin of indetermination in the composite which exceeds it and can cause it to lack, or to achieve, an effect in no way predetermined in the nature, neither particular nor universal, since this margin exists for the entire universe.

c) *Chance is a cause and not an effect.* "[E]x quo non quodlibet quod fit habet causam per se, palam, quod in futuris contingentibus, effectus futuri reductio ad causam per se vadit usque ad aliquod principium; quod quidem principium non reductur in aliquod principium adhuc per se, sed ipsum erit cuius causa 'erit quodcumque evenit,' idest *causa casualis*, et illius causae casualis non erit aliqua alia causa. . . ." ¹⁸ If chance were an effect, it would remain to ask what is its cause, and so on to infinity. One must accordingly distinguish between *casus* and the *casuale*. Between chance and the phenomenon produced by chance there is all the distance between indetermination

and determination. So there is no distinction to be made here between contingency and indetermination. The effect is determined and as such is not contingent. "Nec distinguere debet inter contingentiam et indifferentiam seu indeterminacionem, ut aliqui faciunt," says John of St. Thomas, "quia contingens dicitur aliquid ex causa indifferenti ad utrumlibet in actu primo et antequam effectus producat, ex eadem parte, ex qua habet contingentiam, habet indeterminacionem, scilicet ex causis: extra causas autem nondum aliquid habet, vel si aliquid habet determinate, ibi amittit contingentiam ubi habet determinationem."¹⁹ Once we know the direction taken by two causal lines, we can evidently predict their intersection. As soon as there is a determinate orientation, there is no more chance. When we see an ensemble of converging accidental causes, before they intersect, we are already in a determinate order where there is no longer contingency properly speaking. True contingency and chance are anterior to the direction which will terminate in the intersection: the prediction in question is not made from the side of the proper cause of this phenomenon, but from an effect henceforth determined which will end in the intersection; it is not the prediction of the effect from an indeterminate cause, which would be impossible. The death of our dog therefore is not due to chance in the measure that it is already determined in this constellation produced by cat, dog, tree, wind, etc., but in the measure that this constellation itself has no determinate cause.

d) "Causa per se est finita et determinata; causa autem per accidens est infinita et indeterminata, eo quod infinita uni possunt accidere."²⁰ The dog can die of old age, from sickness, from the fall of a tree; it can do it either by pursuing a cat or burying a bone, etc. The tree can fall because it is rotten, or because of the wind, or a thunderbolt, etc. It can rot because of age, because of insects, etc.

e) *Natural chance is opposed to fortune.* "Omne quod est a fortuna est a casu, sed non convertitur. . . . Casus non solum est in hominibus, qui voluntarie agunt, sed etiam in aliis animalibus, et etiam in rebus inanimatis. . . . Ostendit (Philosophus) in quibus maxime casus differt a fortuna. Et dicit quod maxime differt in illis quae fiunt a natura, quia ibi habet locum casus, sed non fortuna. Cum enim aliquid fit extra naturam in operationibus naturae, puta cum nascitur sextus digitus, tunc non dicimus quod fiat a fortuna, sed magis ab eo quod est per se frustra, idest a casu. Et sic possumus accipere aliam differentiam inter casum et fortunam, quod eorum quae sunt a

casu, causa est intrinseca, sicut eorum quae sunt a natura; eorum vero quae sunt a fortuna, causa est extrinseca, sicut eorum quae sunt a proposito."²¹ The death of our dog is therefore a chance event, but not a fortuitous one.²² Chance is also opposed to art, not only because the principle of the latter is extrinsic, but because it involves finality, and in that art differs from fortune.²³ It is also distinct from the violent, "quod est a principio extrinseco vim passo non conferente." The violent can enter into a chance phenomenon, but it is not as violent that it is cause of accident, since it is a determinate and extrinsic cause.²⁴ Finally, chance and 'the vain' must be distinguished, since chance involves a determinate effect.²⁵ It is not insofar as it is violent that the tree is the cause of the dog's accidental death, and it would not have fallen in vain if it did not kill the dog.

f) "[H]uiusmodi causae (quae ordinantur ad suos effectus non ex necessitate sed ut in pluribus), non deficiunt in minori parte, nisi propter aliquam causam impediendam. . . ."²⁶ But if this cause is determinate, how can we speak of chance? Must we not say with Suarez, "sicut naturalis causa proxima non impedita et habens materiam aptam sufficienter applicatam, necessario producit proportionatum effectum, ita si eadem causa sit omnino impedita, eadem necessitate nihil operabitur, vel si non omnino, sed ex parte impedita est, eadem necessitate faciet imperfectum et monstruosum effectum; ergo si causae omnes tam agentes quam impediendae ex solo naturali ac necessario cursu ita conveniunt, et singulae etiam cum necessitate operantur suo modo, id est, quae impedit, necessario impedit, et quae materiam applicat, necessario, et sic de aliis; ergo talis effectus consideratus in ordine ad totam seriem et collectionem talium causarum, non habet contingentiam, sed necessitatem?"²⁷ In this case, chance would be reduced to a pure encounter, it is no longer an intrinsic cause, it is no longer truly contingent: "extrinsece dicitur effectus contingens, quando carentia necessitatis quae in illo est, solum est ab extrinsecis impediendis."²⁸ These principles being given, Suarez is perfectly right in saying that chance is contingent only secundum quid, and that in this domain there cannot be any future contingents. But that is the great difference between the Stoics and St. Thomas. "Stoici vero distinxerunt (possibile et necessarium) secundum exteriora prohibentia. Dixerunt enim necessarium esse illud quod non potest prohiberi quin sit verum; impossibile vero quod semper prohibetur a veritate; possibile vero quod potest prohiberi vel non prohiberi. (Haec) autem distinctio videtur esse incompetens . . .

(quia) assignatio est ab exteriori et quasi per accidens; non enim ideo aliquid est necessarium, quia non habet impedimentum, sed quia est necessarium, ideo impedimentum habere non potest."²⁹ With these words, St. Thomas rejects the distinction between the necessary of fact and the necessary by right applied to the contingency of nature. "Et ideo alii melius ista distinxerunt secundum naturam rerum, ut scilicet dicatur illud necessarium, quod in sua natura determinatum est solum ad esse; impossibile autem quod est determinatum solum ad non esse; possibile autem quod ad neutrum est omnino determinatum, sive se habeat magis ad unum quam ad alterum, sive se habeat aequaliter ad utrumque, quod dicitur contingens ad utrumlibet."³⁰

If chance is an intrinsic cause, there is an analogy with divine causality in our exercise of freedom and its causality in chance, which is also in a certain manner in nature as liberty is in our will. But in the conception of Suarez, God is immediately and exclusively cause of chance. For any given constellation selected necessarily entails such interferences predetermined in that constellation. These interferences would not be due to chance save insofar as God could have chosen another constellation.³¹ For St. Thomas, on the contrary, it is the indeterminateness that any constellation involves which is the cause of the effects of chance: future and contingent encounters have their cause, not in the constellation insofar as it is determinate, but in the indeterminateness, the indefinite margin of matter exceeding form.

Let us note that the hypothetical necessity of which Aristotle speaks (*Physics* II, 9; *On Generation and Corruption*, chap. 11) goes from the consequent to the antecedent, and not vice versa. If the consequent is given, the antecedent was necessary in order for the consequent to be given. The necessity of the antecedent is grounded in the consequent, and not vice versa. The antecedent is only hypothetically necessary: "Quod autem habet necessitatem ab eo quod est posterius in esse, est necessarium ex conditione, vel suppositione; ut puta si dicatur, necesse est hoc esse si hoc debeat fieri; et huiusmodi necessitas est ex fine et forma in quantum est finis generationis. Quaerere igitur utrum in rebus naturalibus sit necessarium simpliciter aut ex suppositione, nihil aliud est quam quaerere utrum in rebus naturalibus necessitas inveniat ex fine, aut ex materia."³² When we say that, a certain constellation being given, certain effects are hypothetically necessary, we reverse the order. We should rather say: such effects being given, such a constellation was hypothetically necessary. If the effects are accidental they necessarily have a determi-

nate cause. One could also say: given the margin of indeterminateness that the constellation involves, some future contingents—and not this or that future contingent—are hypothetically necessary; which means that the contingency, that is to say, the non-necessity, cannot be impeded. For even hypothetical necessity excludes the possibility of an impediment. If the initial constellation were absolutely determined, effects would be absolutely necessary, and there would be a conversion of terms. In this case, the constellation is no longer hypothetically necessary, but absolutely. And thereby we destroy time. "For that which is necessary is also, at the same time, what always is, since what is necessary cannot not be. It follows that, if a thing exists necessarily, it is eternal, and if it is eternal, it is necessary. Therefore if the generation of something is absolutely necessary, it is necessarily circular and returns to its point of departure."³³ If the point of departure and the term coincide, we have an identity that makes the hypothetical impossible.

If chance is an intrinsic and indeterminate cause, and if this cause has no power to determine itself in one direction rather than another, how can it be in anything other than a purely passive fashion? The casual is a determined phenomenon. There must be a passage from indeterminateness to determination. Thus it is necessary that "tam casus quam fortuna reducuntur ad genus causae moventis: quia casus et fortuna vel est causa eorum quae sunt a natura, vel eorum quae sunt ab intelligentia . . .; unde cum natura et intelligentia sint causae ut unde est principium motus, etiam fortuna et casus ad idem genus reducuntur. Sed tamen, quia casus et fortuna sunt causae per accidens, eorum multitudo est indeterminata."³⁴ A passive potency—and such is the case with chance—can only be actuated by a cause in act. In other words, how can chance be an intrinsic and undetermined cause without liberty? And if the determined impediment is cause of the casual, there is no more chance and the casual is only a metaphor. St. Thomas addressed this difficulty perfectly: "Sed nullum tale principium invenitur in rebus naturalibus, quod habeat libertatem sequendi vel non sequendi impressiones caelestes. Unde videtur quod in talibus, ad minus, omnia ex necessitate proveniant: secundum antiquam quorundam rationem, qui, supponentes omne quod est causam habere, et quod, posita causa, ex necessitate ponitur effectus, concludebant quod omnia ex necessitate contingunt" and if moreover "ipsam impedimentum talis causae (impedibilis) ex necessitate contingit," how can the effect be contingent?³⁵

One must distinguish between the "impedimentum ex parte agentis, vel ex parte recipientis actione," and the latter is nothing other than the *possibilitas materiae*.³⁶ There are active obstacles and passive obstacles. The former is determined. But it is not an impediment insofar as it is determined, but in relation to that which can be impeded or not because of the matter: "Impedimentum enim duo dicitur," Cajetan observes, "scilicet rem quae impedit; et relationem ad aliud ex qua (relatione) denominatur impedimentum."³⁷ And one must also distinguish in the passive obstacle the indisposition due to other determinate causes (if the dog had not eaten, it would have been quicker) and the natural indisposition one finds in every corruptible thing because of matter. The latter is the cause of the casual effect. One also sees how, in the final account, every obstacle that enters into play in the phenomenon of chance is grounded in indeterminateness: "potentia defectiva quocunque defectu, ad potentiam passivam reducitur."³⁸

Let us note that the margin of indeterminateness which exceeds the form and this form itself are incommensurable, since matter is indeterminateness. Suarez speaks of the one and the other as if their conjunction permitted us to establish in advance what will result: "si non omnino, sed ex parte impedita sit, eadem necessitate..." The form is definite, but the margin of indeterminateness always remains indefinite, even if its range diminishes according to the perfection of the form. To say that "there no longer remains but a *certain* quantity of indeterminateness" is to suppress indeterminateness. All we can say is that, given the perfection of the form, there will be that much more probability that it will conquer the matter. That matter should play no role is not determined in advance.

The effect of chance is characterized by its lack of unity: it does not have sufficient determination to be an *unum per se*. Under this aspect, it is something privative, a determination which fails from the point of view of intention. I say from the point of view of intention, since the fact of finding a bone while running after the cat is a happy coincidence for the dog. Chance then is not a determinate cause, but a cause of insufficient determination, a cause of the absence of unity. We ought not therefore have recourse to a power which determines itself to one direction rather than another in order to explain the phenomena of chance.

g) *Talis concursus non habet causam in quantum est per accidens*.³⁹ It is often said that chance is brought on by the encounter of a plurality of causes

and that because these causes are not ordered per se to this encounter, their intersection is only accidental. It is clear that in this hypothesis the phenomenon of chance is perfectly foreseeable, for it would suffice to know the orientation of these determinate causes. Unfortunately, this suppresses the very idea of a cause per accidens. The plurality of which Aristotle and St. Thomas speak is indefinite as the *possibilitas materiae*, and as soon as a determination (orientation) is introduced, there is no longer plurality. In the example we have been using, the plurality is not constituted by the dog, the cat, the tree, the wind, etc. There is a plurality in the dog that can die and in the tree that can fall for quite other reasons. As soon as the death of the dog is determined by the ensemble of factors constituting this constellation, there is no longer plurality, while there are always several causal series: for it is neither these determined causal series or their accidental orientation, nor their encounter, which causes the effect as effect of chance. The accidental concurrence, as it is *habitually understood*, is not the cause of the casual: it is already an effect. This concursus so understood is accidental because it has no determinate cause. "Et propter hoc, id quod ex tali concursu sequitur, non reducitur in aliquam causam praesistentem, ex qua ex necessitate sequatur," because the concurrence itself, as accidental, is not a determinate cause.⁴⁰

h) "Haec enim contingentia, si ulterius in causam caelestem deducantur, nulla horum inventientur non esse per accidens."⁴¹ Who does not see that we often attribute to chance what is quite natural? Does not progress in science consist precisely in eliminating more and more this appearance of chance? No doubt. But then what allows me to say that chance is the cause of the death of the dog? This is because we have chosen a particularly privileged example. We know sufficiently what is a dog and what a tree to judge the proposition: "the death of the dog is caused by the fall of the tree" has only accidental unity, therefore an indeterminate cause. It is only when the terms of the proposition are not sufficiently known that it is impossible to choose between nature and chance. Let us repeat again that the factors that permitted me to foresee the coincidence are not the cause of the accident, even if this convergence has been determined for ages. It is one thing to establish that a phenomenon is due to chance, and another to determine the moment from which this phenomenon was predetermined. And if the effect truly lacks unity one can say in advance that it is impossible to remount indefinitely the series of per se causes. If one could do that, this is because the series of

natural causes would be contradictory among themselves insofar as determined ad unum.

"[I]amen etiam hac reductione facta, inveniuntur esse aliqua per accidens."⁴² There are phenomena which are absolutely unforeseeable, whatever the perfection of the intelligence in play. (I see 'unforeseeable' such that if God could only know effects in their causes, he would not know future contingents.) Let us not say that it could *foresee* for extrinsic reasons, for to the degree that extrinsic reasons determine the future, this future is no longer contingent, but necessary and knowable because it is already present. "[F]utura, secundum quod habent determinationem in causis suis, accedunt ad rationem *praesentium*, in quantum jam quodammodo sunt determinata in causis suis"; "... quia contingentia futura non sunt determinata in causis suis, sed facta determinatione causarum efficiuntur in actu praesentia; et ideo eorum, quamdiu futura sunt, cognitionem (angeli) non habent."⁴³

It is evident that the pure spirits already see futures which appear contingent to us: "quaedam quae contingentia *videntur*."⁴⁴ Their intelligence surpasses ours "in hoc quod contingentiam *determinatorum* is suis causis plura et certius novit."⁴⁵ One cannot find any text of St. Thomas in which he does not take into account this quite essential nuance. Even when he treats of destiny (*fatum*) he ascribes to Providence the necessity of natural future contingents: "ea quae hic per accidens aguntur, *sive in rebus naturalibus* sive in rebus humanis, reducuntur in aliquam causam praeordinantem, quae est providentia divina."⁴⁶ Suarez, on the contrary, can speak of fatal necessity in natural things untroubled by the intervention of free agents; and he can do it because in this domain he rejects future contingents.⁴⁷

When St. Thomas refutes the Stoics—"qui posuerunt fatum in quadam serie, seu connexione causarum, supponentes quod omne quod in hoc mundo accidit habet causam; causa autem posita, necesse est effectum poni. Et si una causa per se non sufficit, multae causae ad hoc concurrentes accipiunt rationem unius causae sufficientis; et ita concludebant quod omnia ex necessitate eveniunt"—he makes appeal not only to human liberty, but even "in aliis corporalibus effectibus rerum corruptibilium, in quibus multa per accidens eveniunt" to created causes which, whatever be their necessity cannot introduce the necessary.⁴⁸

i) *The fecundity of chance and fortune*. "[C]ausa dicitur ex hoc quod consequitur aliquid aliud quod non intendebarur."⁴⁹ When the dog in pur-

suing the cat finds a bone, this was not in his intention; however, it is pleasant and it coincides with another intention, more constant no doubt than that to pursue cats: to chew a bone. The bone enters per se in the intention. But that this intention be accomplished by realizing another, that is accidental. One sees here how chance can rejoin finality with respect to per se causes. If natural causes were to succeed always, being given as well the restrictions due to their very determinations, many happy combinations would be eliminated by that very fact. And if Mr. Kwabberbil had not had the good fortune of meeting Sophie with whom he fell in love when he went to the inn for a glass of beer, all the little Kwabberbils issued from their marriage as per se effects would never have been.

Chance is in no way the proper cause of the natural result of these casual coincidences, but the fact that the encounters arise from per se causes: "id quod est per accidens reducitur ad per se, in quantum accidit ei quod est per se, sicut musicum accidit Socrati, et omne accidens alicui subjecto per se existenti. Et similiter omne quod in aliquo effectu est per accidens consideratur circa aliquem effectum per se: qui quantum ad id quod inest ei per accidens non habet causam per se sed causam per accidens. Oportet enim effectum proportionaliter referre ad causam suam."⁵⁰

Just as a free act can involve happy consequences in no way intended in its determination, so matter has reserves that the determined nature can exploit. Universal nature is not only the sum of particular natures: the whole has its own superabundance that the parts do not. Chance and fortune are in their way necessary for the finality of the world. However this necessity does not predetermine the determined encounters which will take place any more than the necessity of willing happiness deprives us of free will.

One also sees the sense in which we can speak of *creation of possibles*. (Evidently, creation is taken in a large sense here.) And this idea applies not only to chance and fortune but even to nature. We have already said that the infra-human cosmic species are not absolutely certain with regard to their structures, nor true a priori. Each species is new in its structure. Once established, it constitutes a determined point of departure for other species in which the determination of their strain will be in a certain fashion prolonged: this determination has opened the world to essential structures that could not possibly have been determinately possible without it.

II

Before taking up the problem of indeterminism as it is posed for us by the experimental sciences, there must be precision about the sense and value of scientific entities and formally scientific laws.

Every science seeks to reduce the complex to the most simple and to explain it as a function of it. But the meaning of the term 'simple' must be understood. The nature of the simple to which it leads back will profoundly differentiate the sciences. It is easy to show that what we call simple in experimental sciences is quite opposed to what we call simple in philosophy. In experimental science a rock is infinitely more simple than a cell; the movement of a piston is more simple than the leap of a panther onto its prey; of all the beings experimental science studies man is incontestably the most complex. But in philosophy quite the opposite is true. The animal is more simple than the plant, and of all the beings that philosophy of nature studies, it is man who is the most simple; so too in metaphysics the measure and the cause of every being is the absolute simplicity of Pure Act. In physics one measures by the *minima mensura*, time by atomic time, for example; in philosophy the measure is always rich and comprehensive, time is measured by eternity, and both by eternity.

In other words, experimental simplicity is inversely proportional to ontological simplicity. The philosopher will say that the scientist explains the higher by the lower, the perfect by the imperfect. Thus we can say in advance that to the degree that an experimental explanation of man is possible, it will consist in studying him in the perspective of that which is experimentally simpler than he is, not in order to identify the complex and elementary with one another, but to derive the one from the other. It is thus quite natural for the scientist to seek to derive man from the animal, and animal from plant, and to see the whole hierarchy of natural species arise in the direction of an ever increasing and more complex organization. The philosopher who denies the very possibility of an evolutionist theory denies the very essence of the scientific method. If he were logical, he ought also deny the value of the measure of length. Nor can one hope to escape this consequence by saying that the animal and plant are heterogeneous and resist a homogeneous measure. Can we not measure their duration, and the quantitative measure from which it proceeds by the same clock? Moreover, since existence is pro-

portional to essence—quantum unicuique inest de forma, tantum inest ei de virtute essendi—the duration of cosmic beings is also more and more simple, less and less temporal; thus there exists a hierarchy of cosmic durations. But this ontological heterogeneity does not prevent physical time which one defines by its procedure of measurement from embracing all spatio-temporal beings by what is homogeneous in them from the point of view of duration. This common measure is founded on the common genus of corporeity in which all natural beings agree. Physical time attains only their background (*bas-fond*) and touches that only from without. Homogeneity is the basis for every quantitative measurement; this common physical genus sufficiently explains the specific unity of experimental time and why heterogeneity of durations escapes the grasp of a metric calculated on homogeneous exteriority. Experimental science begins there where all beings come together and are one: the graduated scale on the balance shows no difference between 150 pounds of man and 150 pounds of bricks. If physical time touched beings in their ontological and specific ground, if this time exhausted the real, if only from the point of view of duration, the different degrees of being would be only epiphenomena of growing physical complexity. Even if things are more than their outsides, this does not prevent the measure of their homogeneous exteriority from being common and true. These two perspectives are not contraries, they complement one another. Without knowing the experimental complexity of a thing one cannot grasp the richness of its ontological unity.

Confined from the outset to the domain of common sensibles which are all reducible to quantity, having for *formal subject* the measurable aspect of things *as measured*, and the quantitative measure from which it proceeds being found on homogeneous exteriority, experimental science can only touch nature from without and can never go behind what is outside. Being able to attain its object only by means of an artful operation—the scientist *makes experiments*⁵¹—it can only arrive at a concept based on the measurements effected by the repetition of experiences. It takes its proper point of departure in a work of art, the result of a certain procedure of measurement effected in determinate circumstances, and defined by the description of that procedure.⁵² The following passage from Eddington expresses this idea very clearly: "The physical quantity so discovered, is primarily the result of the operations and calculations; it is, so to speak, a *manufactured*

article—manufactured by our operations.”³³ It is the *known quantities*, defined as such, that enter into science. But between the number-measures determined by the graduated scale of an instrument and the *material subject*, there is the fabrication from which one cannot abstract without falling into subjectivism.³⁴ Let us not confuse the prescientific given with the number-measure which is not an immediate and adequate translation of that given. It is not the object in the balance dish that is the proper point of departure of scientific elaboration, but the number on the graduated scale on which the needle rests. Once I have defined the property, I cannot apply it as such to the object, as if the balance were a species of screen and in weighing one peeked ‘behind’ the balance to surprise the bare object. (And that is indeed what one thought he was doing prior to the Einsteinian criticism of the measurements of space and time, forgetting that the very circumstances of measuring are part of the definition and that different circumstances qualitatively change the definition. To say that the quantitatively different definitions of length *ought* to have the same quantitative value is to fall into the relativism from which Einstein has freed us.) Let us not say that the concepts of science rest by definition on a distortion of the world and that thus the documents of the physicists are from the start forged and betray reality. But of course one ought not be abused by this distortion. The documents are faithful in their fashion and only deceive when one gives them a meaning to which they do not pretend. Is light an evil demon who toys with us when a stick plunged in water looks bent? No more than my radio is responsible if my children think there is a monster hidden in the cabinet.

The only things that science can attain are those which can be registered in number-measures. But that in things which permits this—and never forget the distance separating what permits this and the result—is not the whole of the thing: it is only its measurable aspect. And if this measurable aspect is all quite real, that does not mean that one can consider it as existing apart. One cannot derive ontological cuts from metric cuts. The sun and moon are not two substantial beings because they are distant and separated from one another by a certain void. The fundamental entities of physics are only cuts in the metric aspect of things, things from which moreover the physicist wholly abstracts. It is absurd to consider the atom to be a thing. Such entities are real only as a smile is. It is as senseless to speak of the hylomorphic composition of bodies taken in the sense of physics as to

speak of the hylomorphic composition of a smile, even if the smile finds its ultimate reason in rationality, and rationality presupposes prime matter. It is also without meaning to ask if the counterpoint realized in the execution of a symphony is composed of matter and form. Contemporary scholars who indulge in such absurdities—and who manage to amaze their conferees—are legion. A flock of false problems are created in this way. One asks if a molecule of water is an individual, or Siamese twins, *vel aliquid huiusmodi*.

Experimental science can never rid itself of a certain nominalism and never arrives at concepts independent of experience in their structure. It is not a “discipline.” It defines its concepts with reference to concrete experience from which it never completely abstracts, because this experience itself is never complete. The truth of propositions is not justified by their logical coherence; still it is necessary that these propositions are really true, for every experimental science, in the measure that it attains the level of science, is *physico-mathematical*. Newtonian space was three dimensional, Euclidean. That is what experience seems to show. When Einstein arrived, one noticed that the majority of physicists had forgotten the experimental foundation of this idea. They thought that one could now separate the ideal of experience from that which had formulated it, forgetting that the idea has no experimental sense apart from its genesis.

This is because every formally scientific concept is grounded on an incomplete induction indefinitely perfectible—*inductio per descensum* can never rejoin experience to the point of closing the concept and making it a universal properly speaking: its very genesis is never terminated. In other words, experimental science can never attain the first degree of abstraction. But just as nature tends to an ever greater determination, experimental science tends toward the first degree of abstraction.

This is not to call into question the rigor of scientific reasoning nor to contest the logical coherence of a theory. It is when it is a matter of the real value of deductions from a theory that one observes their inadequate character. Let a determinist mechanics be as necessary and absolute as one wishes, is it really true? Or can one at least imagine experiences which would confirm it? If not, in what sense can it be called physical? If the confirmation of a principle has to await a future indefinitely remote, it loses by that very fact its experimental character: it is methodologically false.

But that is the case with what is called the principle of causality in experimental science. According to this principle the entire future will be rigorously predetermined in the present, and a sufficiently powerful intelligence, etc. We know the hypothesis of Laplace.

The principle will be immanent in every law of behavior. (Excluded by this fact are the laws of identity—and perhaps the transcendental laws of atomicity—since they abstract from the relation of the present to the future.⁵⁵ Thus the law of the conservation of energy is by definition invariable—which is not to say that it is really true.) The character of the second law of thermodynamics will be purely subjective. The impossibility of inserting the fundamental entities of the physical world into a space-time scheme always and rigorously determined will be due to our ignorance, or even to the accidental or essential defectiveness of our means of observation.

Moreover, no modern scientist pretends to formulate experimentally a law of rigorous behavior. All the known laws are statistical, which does not prevent their explaining sufficiently the observed regularities. But there is no agreement on the future of these laws. Some think that one day this statistical character will be replaced by absolute rigor; others are convinced that it is necessary to reject definitively the determinist ideal, and that even if there is determinism in the world, we could never know it.

The principle of determinism deserves to be called physical only if it can be verified in experience. Everyone agrees on that, even the determinists.⁵⁶ But one can demonstrate that this principle postulates an impossible experience.

Let us suppose a super-physicist contemplating a finite spatio-temporal world from its beginning to its end. (One must indeed close this universe even from the point of view of time if we posit as condition a complete experience.) When the farce has been thus enacted, he has observed that all phenomena have unfolded with perfect regularity and are inserted in the differential equation that he originally formulated. Could one deduce from this that this universe has been ruled by absolutely rigorous laws? That is probably what he would do if he lacked imagination. But if he wants to explain what has happened, if he is not content to write natural history, he will show that even if the behavior of isolated microscopic entities had been undetermined, being given their large number, the development of this universe would have been sensibly such as it has been. He would never be able to say that the de-

velopment could not have been other than it has been. In order to be certain, he would have to make everything rebegin indefinitely. And then?

We should not say that experience would be sufficient only if this universe had realized all possible cases. But if we must imagine as matter of ideal experience a universe where all possible cases are realized, it would be easy to imagine a super-physicist and have him await the end of the development: such a universe would be by definition determinist; knowledge of the initial constellation would be sufficient, and if it was sufficient, there would be no need to await the outcome.

One calls this a *petitio principii*. The determinist posits a principle which allows him to predict the future absolutely, but whose value depends on the future. If the future were present, the principle would no longer make sense. But to show that it makes sense, it is necessary that the future be present. As Eddington would say: the determinist can make prophecies only after the accomplishment of facts. Note that he cannot demonstrate it a priori. If demonstration there be, it could only be philosophical. He could say: every effect has a cause. But effect and cause have a quite different sense in philosophy; moreover, the effect is proportioned to the cause: every effect requires only an equally determined cause. This proportionality is necessary in virtue of the ontological principle of causality itself. And after making the transposition of this principle to the experimental order, he would notice that in physics there is question only of a certain formal, not efficient, causality: it only expresses a metric coherence of phenomena. What could be more natural, since his science is *physico-mathematical*.

At bottom, it is time that rebels against the physical principle of causality and is the enemy of the determinist. Even if the entire past had realized his hopes, the future will still be uncertain, unless he can demonstrate that the future is present and that he suppresses time. In this case the principle of causality becomes absolutely useless—there is no longer anything to predict.

Not only does he do metaphysics in conceiving physical entities as things entirely determined in themselves: he spatializes time. To exist, he tells himself, is to be somewhere at a certain moment. If a particle ceases to be somewhere, it ceases to exist, and vice versa. Since it is always, we must be able to follow its trace; its trajectory must be simultaneously a spatial value and a temporal value: it cannot have the one in isolation without ceasing to exist. Still, if we cannot determine both the position and the velocity of an electron,

this is because our knowledge of this phenomenon is still insufficient. As in reality the two are determined together, the scientist ought to seek to know them experimentally as such.

Such reasoning would be troublesome if their terms had an ontological meaning. But if one sets philosophical prejudices aside, if one holds to their purely physical meaning, no difficulty is presented. The contradiction only appears at the moment when we confuse the two domains, at the moment where we give to space, to time, and to the corpuscule a directly ontological meaning. Evidently, if one claims the right to confuse, the confusion poses an insoluble problem. But note, too, that the beings of which we speak in the philosophy of nature are from the metric point of view macroscopic ensembles for which this question does not arise. With what right does one attribute the properties of the ensemble to each of its constituents individually taken?

Certainly, it is not experience that allows us to affirm that there exists on the microscopic scale a perfect symmetry between space and time. This symmetry only appears on the macroscopic scale and it is perfectly compatible with a dissymmetry in the components. The uncertainty of the individual throws of a die does not impede us from making predictions about a large number of throws, predictions whose certainty augments with the size of the ensemble. The ensemble has a determination that the parts do not.

It has been pretended that the certitude that bears on an ensemble presupposes a determinism on the side of the components. This affirmation is at the least strange. One cannot all the same contest the outcome of the predictions. I do not know which facet will be presented in the individual throws, but this ignorance does not impede me from predicting that in six thousand throws, the facets will be equally distributed. If this prediction is not verified, I would have suspicions about the die and not about my calculation. The only thing I have to know at the outset is the number of alternatives, the equiprobability of these alternatives, the independence of the individual throws and their number. If the alternatives are not equiprobable, that is, if there is not perfect indetermination within the limits of the determined number of alternatives, my prediction will be false. Macroscopic determinism is conditioned by microscopic indeterminism. Moreover, the kind of determinism in question cannot be absolute, for that would presuppose an actual infinite of constituents, that is, a contradiction.

Time should not embarrass the determinist since his principle denies it in advance. For to establish a perfect symmetry between time and space is to deny time, it is to immobilize the universe from the point of view of duration and render it absolutely reversible.

Let us consider for a moment the astronomical hypothesis of Father Lemaitre. There seems to exist between the law of the degradation of energy and the expansion of the universe a constant relation: the entropy of the universe is proportional to its volume. "The augmentation of entropy which characterizes the direction of evolution is the progressive fragmentation of the energy which exists at the beginning in a unique package."³⁷ The scattering comprises a growth of the world. For growing disorder takes more and more space, or rather, disorder makes more and more space. An assembled toy cannot be inserted in its box save on condition that all the parts are put in good order. The initial state and the present state of the universe are comparable to a valise which at the outset is well ordered and at the end of the trip cannot be closed without being sat upon. While the expansion of a man comes about thanks to borrowing from his milieu, the expansion of the universe—since it is not in a milieu but itself constitutes the milieu—cannot take place at the expense of the milieu. For it there exist no reserves of time and space: it cannot borrow from volume for its volume. It cannot snowball. It must inflate from its own substance like a soap bubble. The collapse of the world should lead to the new—a new which must be drawn from within the universe. This new cannot be spatio-temporally determined in the present world: otherwise the new would be always present and time would not advance. The new of the future can be true only in the present possibility of a future disorder. The fading away of the present order is a condition of the new. Let us not say that disorder can be determinately foreseen in all respects, since that would suppose that it already has a determinate spatio-temporal value. But in what would the progression of time then consist? It is indeed necessary that there exist in the present a certain dose of indetermination with respect to the future. The direction of time is only true and objective if a certain indeterminism exists in the world. That is to say that tomorrow can only be true on condition that it is not entirely today. By this indeterminism of the microscopic order we can explain the novelty necessary if the direction of time is to have a real value, and the regularity of the macroscopic order where a determinism bordering on necessity and certitude can reign.

What is so reprehensible in the following affirmation: If at instance t' the electron e is in the orbit b , that does not mean that at the instant t it was determinately true that at instant t' it will be in the orbit b ? For Heisenberg could it not be said that the question of knowing whether a complete knowledge of the past can predict the future does not arise, since a complete knowledge of the past implies a contradiction? Does not the philosopher also say: "Si enim similiter se habet veritas et falsitas in praesentibus et futuris, sequitur ut quidquid verum est de praesenti, etiam fuerit verum de futuro, eo modo quo est verum de praesenti... ergo si ante unum diem verum fuit dicere quod erit album sequitur quod semper fuit verum dicere de quolibet eorum quae facta sunt, quod erit... Sequitur ergo ex praemissis quod omnia, quae futura sunt, necesse est fieri... Ergo est falsum scilicet quod omne quod est verum esse, verum fuerit determinate dicere esse futurum."³⁸ It is right to cite this text since the difficulties raised against the proposition are purely philosophical.

Let us not say that if there exist equal alternatives for the fundamental entities of physics, the macroscopic order is a result of chance, the universe is ruled by the laws of chance. Let us not be duped by words. Since a statistical law expresses a regularity, one ought not give the current expression "law of chance" a philosophical meaning. If a comparison must be made, should not "chance" be translated as improbable? As for the law of large numbers that the universe follows from the physical point of view, is not this tendency toward unity just a sign of nature? But rapprochements are dangerous in this domain and require a more profound study which we will have occasion to give elsewhere.

Too univocal rapprochements between physical indeterminism and the indeterminism we encounter in experimental biology have been made, as if the one were a reenforcement of the other. The spontaneity of microscopic entities is spoken of as if it were of the genus of life. If this were only a simple analogy, I see nothing reprehensible in it. But if one takes the term 'spontaneity' in its rigorous sense the assimilation cannot be admitted.

All the beings that we encounter are composed of atoms: the inorganic world, potatoes, rats, professors, etc. All are composed of purely physical elements. Yes, but while all beings are covered by the physical point of view, this point of view does not cover the whole of these beings; it is neither exclusive nor exhaustive. Nothing among the living goes against the principle

of the conservation of energy—supposing this principle to be true and that the degradation of energy is objectively statistical. The atoms of a man are as truly physical atoms as those of a rock. But the atoms are not parts of beings as bricks are of a house. The physical world is only one of the metric aspects of the universe. How should we distinguish the world of experimental biology from that of physics? Life is not inserted into the physical world like a coin. They are not distinct like things juxtaposed or superimposed. A living being is not opposed to a physical being but to a non-living being. Most authors seem to confuse the physical world with the inorganic world. But this confusion can be explained. While from the experimental point of view physical laws sufficiently explain inorganic phenomena, these same laws, even while being verified of the living being, do not suffice to explain the whole of the metric and experimental aspect of the living. Phenomena present themselves which, without being contrary to physics, oblige us to formulate laws proper to living things: formally biological laws.

Let us adopt a more restricted point of view that will make this opposition clearer. Whereas the physicist observes in the world a greater and greater disorganization and diffusion, the biologist encounters living islands, on the way to a higher and higher organization, toward a more intense concentration. Like a trout or salmon mounting rapids, life seems to progress against and despite the current of degradation that carries the physical world toward extinction. Nutrition which is assimilative and enriching from the biological point of view is combustion from the physical point of view. And the higher forms of life eat the lower. Life is organized by disorganizing. The universe, in expansion from the physical point of view, rebounds on itself in life, thus constituting centers of density ever more heterogeneous. To employ an image: just as a toy to be assembled is not made in order to remain neatly stored in its box, but to make marionettes, the physical universe also serves a higher goal which it approaches by losing its initial state of organization. The universe unpacks its matter in view of a higher construction. It is like the eggshell which breaks in order to free the chick.

Let us now apply this distinction to the question of indeterminism. The physical world, even living things, tends toward disorder. From the physical point of view, there is more and more chance in the world. The more loosed and scattered, the more difficult is it to predict the behavior of physical entities. Let us say that on this scale unpredictability is proportional to the degree

of entropy, entropy being the measure of disorder. (One could object that the universe, in approaching the state of thermodynamic equilibrium, becomes, in this way, more and more determined, and that predictability ought to increase in proportion. But that would be to forget that this equilibrium is characterized by the absence of time and of a future to foresee.)

The biologist observes an analogous phenomenon. But for him predictability is proportional to the degree of organization: the more organization there is, the more spontaneity, a spontaneity which, like chance, escapes the grasp of metric rigor. Arrived at man, who presents a maximum of organization, characteristic behavior involves the absolutely unforeseeable: his liberty gives him a degree of spontaneity that entirely escapes the grasp of the metric. In living things spontaneity emanates from the subject, it results from an interior integration, it is the measure of the degree of interiority.

I well know that these considerations will not interest the biologist. This classification of living things according to their degree of spontaneity would even make most of them laugh, so much more so since a good number of them are still mechanists. Even while admitting spontaneity, it is extremely difficult to know in what measure the margin of indetermination is due to our ignorance and in what measure it is objective. But I do not think I will scandalize biologists by saying that the behavior of a dog is more spontaneous than that of infusoria.

In philosophy of science these considerations are capital. Between the opposition we have just introduced and that between positive and negative indetermination, a symmetry evidently suggests itself. The ontological opposition is manifestly the root of the first. Let it suffice to say here that when one speaks of spontaneity in the physical world, one uses this term in a completely improper sense.⁵⁹

Here is another philosophical reflection that can appear ridiculous in the eyes of the biologist. In the domains where one can observe them, mutations are produced with a certain frequency, but by chance. Taking account of the particular characteristics of each species which determines this frequency, these hereditary variations seem to appear according to the law of large numbers. It is for genetics to provide an experimental explanation of this phenomenon. How might one interpret it in philosophy? Let us say immediately that this interpretation is completely devoid of sense in experimental biology. The philosophy of nature teaches us that the infra-human

living species are purely functional. They exist only as a provisory state of the universe and are made to disappear. The multiplication of their individuals cannot be itself its end: it must be essentially ordered to something else which transcends the species. It should signify a qualitative enrichment of the species without which it would be a pure diffusion in quantity. This enrichment has no place in the individuals taken in isolation, it is a quality of the ensemble. In this multiplication the ensemble must become more and more determined and certain. Since this numerical increase cannot lose itself in the indefinite, it must have an approximative term, determined by the nature of its own species. This term will be the mutation. It will be produced by chance, that is, no individual of the species taken in isolation is especially disposed to undergo it. The regressive or indifferent character of most mutations and the weak probability of their persistence takes nothing away from the value of this explanation: they are quite simply signs of the resistance of matter. It is only in the rarest of exceptions that universal nature attains its term. We have only to think of humankind.

III

The consequences of hylomorphic composition are thus the objective foundation of the distinction between the experimental sciences and the disciplines. Philosophy of nature, being *scientia certa per causas*, can only attain what is essential and necessary to nature, such as the hylomorphic composition of natural substances, the contingency this composition entails, the necessity of evolution, the necessity of humanity as the ultimate end of this ascension of the world, etc. In short, what one can establish with rigor are what Maritain calls *philosophical facts*.

Experimental science, on the contrary, to the degree that it does not confine itself to pure truisms and tautologies, to the degree that it is an explanatory science, can only give us a probable knowledge of things. I am not speaking of particular observations which can be perfectly certain, but of the laws of behavior and of theories. These probabilities can achieve enormous proportions, they can provide what we call practical certitude, to the point where they create the illusion of absolute certitude. But one can never lead them back to the principle of contradiction as can be done in the disciplines.⁶⁰ The

scientist can think that this indefinitely achieved character of his science derives exclusively from the method he must employ. He can believe that the margin of incertitude is purely subjective. In fact, the progress of the sciences consists in reducing this margin of subjectivity. That is why, from the point of view of experimental research, it is rather indifferent whether a scientist be a determinist or an indeterminist, although the determinist exposes himself to getting lost in impasses created by his philosophical prejudices which cause him to postulate more than is necessary to explain known phenomena—even knowable, the indeterminists would say. Notice, moreover, that in philosophy of science we must distinguish between the methodological principle of indeterminism according to which it is impossible to formulate other than statistical experimental laws, even if there is determinism in nature, and an experimental principle of indeterminism, such as Heisenberg's relation of uncertainty. If in the future the latter is proved defective, the first would remain intact. It is the same with the methodological principle of relativity and experimental principles.

St. Thomas underscores many times the ontological cause of this uncertainty: "in istis causis effectus futuri non habet certitudinem absolutam, sed quamdam, inquantum sunt magis determinatae causae ad unum quam ad aliud; et ideo per istas causas potest accipi scientia conjecturalis de futuris, quae tanto magis erit certa, quanto causae sunt magis determinatae ad unum; sicut est cognitio medici de sanitate et morte futura, et iudicium astrologi de ventis et pluviis futuris."⁶¹ Because there are more or less contingent fluctuations in nature and degrees of spontaneity, the analytic method of the philosophy of mobile being cannot furnish an adequate and comprehensive knowledge of the cosmos. The philosopher of nature becomes a dialectician in the pejorative sense as soon as he considers his method to be exhaustive and extends it to that aspect of the world which is never totally separable from individual matter, which is resistant to complete abstraction and which can only be followed by the sense appropriate to the contingent. This measurable outside of the real moving thing, this domain where perfect certainty is impossible, is the necessary consequence of mobility. Abstracting from the margin of subjective uncertainty, the distinction we make between two degrees of knowledge, between these two modes of defining, does not derive exclusively from a partitioning necessitated by our psychological structure—it derives as well from the very nature of things. The same cause explains both

the abstractive and rational character of our understanding and the fundamental opposition between these two degrees of knowledge—matter. The opposition designated for us exists as well for intelligences which do not know by experience. (There is no reason why a pure spirit should be able to predict the future position of an individual electron.)

It is in philosophy of science, the sapiential function of the philosophy of nature, a role which it shares with mathematics, that we combine these two modes of definition. For the philosophy of nature is both science and wisdom.⁶² Metaphysics is wisdom because it has being as its formal subject, because it makes the tour of being and because of that can reflect on itself in explaining itself by its chief subject, God, and in defending against the natural doubt of human intelligence. But metaphysics, by the very fact that it makes a tour of being and can reflect on itself, includes as well in a certain fashion all the sciences inferior to it. It can judge them, defend them, use them, and explain them in its fashion. Reflecting on mathematics, it becomes philosophy of mathematics. For the philosophy of mathematics is formally metaphysical; it is in the third degree of abstraction. Making use of formally mathematical data it is itself only materially mathematical since it judges them in its proper light. Metaphysics plays the same sapiential role with respect to the philosophy of nature: there is a metaphysics of the philosophy of nature. It is just this need to reflect metaphysically on the content of the philosophy of nature that explains why so many modern scholastics have adopted the Wolfian division of philosophy.

It is by this sapiential function in which metaphysics departs from itself as science while still remaining in the domain of nature that philosophy of nature participates. It cannot be wisdom with respect to itself as metaphysics can, since it cannot touch on the absolute ground of its subject, mobile being: the being that it grasps only under the angle of mobility. But this very mobility comprises two aspects: the one necessary which it treats insofar as it is a science, the other which escapes *cognitio certa per causas*, but which characterizes the experimental sciences which move in the chiaroscuro of this world which tends to necessity.

Just as the quidditative intuition of the divine essence by the blessed does not yield a comprehensive knowledge of this essence and its indefinite participability, so metaphysics which attains the quiddity of being cannot tell us all the ways it can be realized, and so, too, the philosophy of nature cannot

tell us all the ways in which the mobile, that *fluxibile et non semper eodem modo se habens propter materiam*, can be fashioned. But once this aspect that escapes us is disengaged by the experimental sciences, it can reflect on it without leaving the domain of mobility which is always its. It can judge, defend, and use the experimental sciences, but it can do so only in the measure that the sciences are first closed on themselves and are autonomous.

NOTES

1. "... qui est contingens respectu causae proximae naturaliter operantis, si comparatur ad totum ordinem et seriem causarum universi, et in his causis nulla intercedat libere agens, saltem ut applicans alias causas, vel removens impedimenta, non habet contingentiam, sed necessitatem" (*Disputationes metaphysicae*, disp. 19, sect. 10, par. 5).
2. Opus. II: *De scientia Dei futurorum contingentium absolutiorum*, c. 1. "Contingentia vero illa dicitur esse secundum quid, quia est tantum respectu unius causae, ut impediri potest ab alia; non vero respectu totius collectionis occurrentium causarum" (par. 1). Compare John of St. Thomas, *Cursus Theologiae*, ed. Solesmes, t. 2, p. 410: "In causis autem creatis non possunt cognosci futura contingentia, quantumcumque causae accumularentur: quia illae omnes contingentiam non sufficient exaurire, nisi forte causae istae sumuntur ut determinatae a Deo, et subiectae ipsi decreto sic causanti determinationem futuritionis." Vasquez, *Com. Ac Disput. In Iam Partem* (Anvers, Belletos) in disp. 64, c. 1, p. 338, and in disp. 207, p. 515. "An futura contingentia ex aliis causis naturalibus proveniant, ab angelo cognosci possunt) makes a clear distinction between future contingents necessary by nature and thus foreseeable, and non-necessary and unforeseeable future contingents, founded in liberty."
3. *Disputationes metaphysicae*, disp. 19, sect. 10, par. 13. It is important to note that Molina (*Concordia Liberi Arbitrii*) makes an exception for the spontaneity of animals: "Si seculdas liberum arbitrium tam hominum quam angelorum, atque appetitum sentientem bestiarum ad actus quosdam in quolibet cernitur vestigium libertatis, propositis constitutione mundi universi qua nunc est" (q. 14, art. 13, disp. 47).
4. "Libertas a necessaria coactione nobilis invenitur in Deo, quam in angelo, et in uno angelo quam in alio, et in angelo quam in homine" (*In II Sent.*, d. 25, q. 1, a. 4).
5. John of St. Thomas, *Cursus Theologicus*, t. 2, p. 575, n. 15.
6. "Anima sensibilis, cum non sit res subsistens, non est quidditas, sicut nec aliae formae materiales, sed est pars quidditatis, et esse suum est in concrezione ad materiam..." (St. Thomas, *Q.D. de potentia*, q. 3, a. 11, ad 11).
7. Serillanges, O.P., *Saint Thomas d'Aquin*, 4th ed., t. 2, pp. 20 ff.

8. Aristotle, *Prior Analytics* I, c. xii (xiii) (ed. Didot): "Contingere aliquid dici duobus modis: uno quidem, quo ut plurimum fieri aliquid, non tamen necessario, dicitur; ut canescere hominem, aut augeri, aut corrumpi, aut omnino, quod natura esse potest (hoc enim non continuam necessitatem, quum homo non semper vivat [ad justam aetatem perveniat]; si autem vixerit, aut ex necessitate canescit, augetur, minuitur, aut ut plurimum ut id fiat contingit); altero autem modo contingere dicitur indefinitum, quod et sic et non sic esse potest; ut animal progredi, et progrediente animale terrae motum fieri, aut omnino in quod fortuito fit. Nihil enim magis sic fieri natum est, quam ratione contraria."

9. John of St. Thomas, *Cursus Philosophicus*, ed. Reiser, t. 2, pp. 180 ff.
10. St. Thomas, *Summa theologiae*, Ia, q. 86, a. 3. See Cajetan's commentary.
11. *In I Perihemenias*, lectio 14, n. 9.
12. *Summa theologiae*, Ia, q. 86, a. 3, c. See Cajetan's commentary n. 9.
13. *III Summa contra gentes*, c. 86: "Adhuc, ex multis contingentibus non potest fieri unum necessarium, quia, sicut quodlibet contingentium per se diffcere potest ab effectu, et omnia simul. Contat autem..."
14. *In I Perihemenias*, lectio 14, n. 8.
15. *III Summa contra gentes*, c. 86: "Impressiones enim causarum naturalium recipiuntur in effectibus secundum recipientium modum. Haec autem inferiora sunt fluxibilia et non semper eodem modo se habentia, propter materiam, quae est in potentia ad plures formas, et propter contrarietatem formarum et virtutum. Non igitur impressiones corporum caelestium recipiuntur in istis inferioribus per modum necessitatis."
16. *In I Perihemenias*, lectio 14, n. 14.
17. *In VI Metaphysicorum*, lectio 2, n. 1182.
18. *Ibid.*, lectio 3, n. 1201. John of St. Thomas, *Cursus Philosophicus*, t. 2, p. 510.
19. John of St. Thomas, *Cursus Theologicus*, t. 2, p. 420. *Ibid.*, p. 410: "Neque enim contingentia rei consistit nisi in ordine ad futurum, quia quod iam est praesens vel praeteritum, extra contingentiam est in eo quod iam est; solum autem est contingens in eo in quo deest, et quod futurum restat. Si ergo contingens fundat de se futuritionem contingentem et impedibilem, ergo indeterminatum, et ita quando est in statu futuritionis, est in statu indeterminatus."
20. *In II Physicorum*, lectio 8, n. 8.
21. *Ibid.*, lectio 10, passim. *Q.D. de malo*, q. 16, a. 7, ad 16.
22. However, in the degree that living things are endowed with spontaneity, they participate extrinsically in fortune.
23. *In VI Metaphysicorum*, lectio 2, n. 1185; *In VI Ethicorum*, lect. 3, n. 1159.
24. *In V Metaphysicorum*, lectio 6, nn. 829 ff.
25. *In II Physicorum*, lectio 10, n. 9.
26. *Summa theologiae*, Ia, q. 115, a. 6, c.
27. *Disputationes Metaphysicae*, disp. 19, sect. 10, par. 5.
28. *Ibid.*, par. 4.
29. *In I Perihemenias*, lectio 14, n. 8. See as well *III Summa contra gentes* 86: "Si autem aliquis forte dicat..."

30. Ibid.
31. Suarez, *Disputationes Metaphysicae*, disp. 19, sect. 10, par. 13.
32. *In II Physicorum*, lectio 15, n. 2.
33. *On Generation and Corruption*, II, c. 11, 357a35. The celestial mechanics of the ancients was determinist just because they conceived the paths of the stars to be cycles completely closed in on themselves. Necessity was defined by the identity of the cycle, and the duration of celestial bodies was measured not by time, but by the *aeonum*. Nowadays we would say that they reduced all astronomical laws to laws of identity which abstract from the progression of time and are by definition inviolable.
34. *In II Physicorum*, lectio 11, n. 11.
35. *Summa theologiae* 1a, q. 115, a. 6, c. See the profound commentary of Cajetan in which he avows "Et haec ratio multo tempore me vinctum tenuisse videtur."
36. *In II Sent.*, d. 3, q. 3, a. 3, ad 4.
37. Cajetan, 1a, q. 115, a. 6, c, n. xvii.
38. Ibid., n. vii. Suarez seems to say the opposite, and it is this that explains his whole position. "Sed hoc non proprie dicitur, nam casus non significat materialiam causam, sed efficientem, respectu cuius nullus est effectus ad utrumlibet contingere, nisi in causis liberis. Nam naturales sunt determinatae ad unum, in liberis autem talis effectus non est casualis ex eo capite, sed liber; erit autem casualis si sit praeter intentionem, quod non invenitur proprie nisi in eis quae raro conjunguntur effectibus per se intentis. Indifferentia autem potentiae materialis nihil refert, ut effectus dicatur casualis, tum quia non sequitur effectus ex vi illius, tum etiam quia ex parte ejus non est effectus per accidens aut praeter intentionem, nam hoc proprie pertinet ad causam efficientem ut per se constat."
39. *Summa theologiae*, 1a, q. 115, a. 6, c.
40. Ibid. See Cajetan nn. xvii and xx.
41. *In VI Metaphysicorum*, lectio 3, n. 121. See for example n. 1206.
42. Ibid., n. 1212.
43. *II Sent.*, d. 6, q. 2, a. 2, ad 2; d. 3, q. 3, a. 3, ad 4. *In XI Metaphysicorum*, lectio 8, n. 2282.
44. *Q.D. de veritate*, q. 8, a. 12.
45. Ibid., ad 6. *Q.D. de malo*, q. 16, a. 7, c.: "Ea vero contingunt ut in pluribus, possunt cognosci in causis suis non per omnimodam certitudinem, sed per conjecturalem quandam cognitionem; certius tamen ab angelis bonis et malis, quam ab hominibus. Considerandum tamen quod cognoscere futurum in causa sua, nihil est aliud, quam cognoscere praesentem inclinationem causae ad effectum; unde hoc non est proprie cognoscere futurum, sed praesens." Ad 11: "Et quae futura sunt, praecesserunt quidem in saeculis praeteritis secundum aliquam similitudinem, non tamen quantum ad omnia; sed forte unus effectus futurus assimilatur diversis effectibus praeteritis quantum ad diversa. Et tamen cognitio quae ex similibus procedit de rebus contingentibus, non habet certitudinem propter transmutabilitatem materiae, sed est cognitio conjecturalis." See as well *Q. Quodlibet.*, VII, a. 3, ad 1.
46. *Summa theologiae*, 1a, q. 116, a. 1, c.

47. *Disputationes Metaphysicae*, sect. xi, par. 9.
 48. *In I Perihemeneias*, lectio 14, nn. 10 ff.
 49. *In I Physicorum*, lectio 10, n. 9. But let us add "quod non omne quod est praeter intentionem oportet esse fortuitum vel casuale, ut prima ratio proponebat. Si enim quod est praeter intentionem sit consequens ad id quod est intentum vel semper vel sicut frequenter, non eveniet fortuito vel casualiter, sicut in eo qui intendit dulcedine vini frui, si ex potatione vini sequitur ebrietas semper vel frequenter, non erit fortuitum vel casuale; esset enim casuale, si sequeretur ut in paucioribus."
 50. *In I Perihemeneias*, lectio 14, n. 13.
 51. Even the comparisons that we effect directly by the senses fall into the category of art as much as those effected by means of manufactured material instruments. "There is no essential distinction between scientific measures and the measures of the senses. In either case our acquaintance with the external world comes to us through material channels; the observer's body can be regarded as part of his laboratory equipment, and so far as we know, it obeys the same laws" (Eddington, *Space, Time and Gravitation* [Cambridge, 1929], chap. 2, p. 31).
 52. See the very precise study of Fernand Renouir, *Physique et philosophie* (Revue Neoscholastique, 1936), 51 ff.
 53. Eddington, *The Mathematical Theory of Relativity*, Introduction. Above all, see *The Nature of the Physical World*, chap. 12.
 54. It is altogether incredible that Eddington has been accused of subjectivism when it is by awareness of this mediate character of physical quantities (*grandsieurs*) that he reestablishes their objective character; only one who confuses these two separate terms of an operation is deceived.
- There is a well-known passage in John of St. Thomas on the distinction between the natural sciences and the true disciplines: "Omnis nostra speculatio dependet ab inductione, sicut dependet a sensu et experientia. Unde si propositiones universales alicujus scientiae non sint ita abstractae et communes, quod ex quocunque individuo manifestari possit ipsarum veritas, sed ex plurimum numeratione et experientia pendeat, sicut scientiae naturales, non sint ita certae sicut aliae scientiae abstractiores et communiores, ut metaphysica et mathematicae, quorum principia etiam in uno individuo habent totam certitudinem, ut 'Quodlibet vel est vel non est' (*Cursus Philosophicus*, t. 1, p. 200). Perhaps John of St. Thomas has not drawn all the methodological consequences of this for his own philosophy of nature, but what seems to me certain is that he never abandons these fundamental theses as being *minus certae*. Moreover, one can easily disengage them by applying the principles stated in the passage. In another passage in this same logical treatise, we read: "Experimentalis cognitio non dicit abstractionem intelligibilem, qua cognoscitur res per suam quidditatem praesertim quia apud nos experientia semper dependet ab aliquibus sensibus. Et sic est *diversa abstractio a scientia*, quae procedit a priori, quantum est ex se" (p. 828).
55. Eddington, *The Mathematical Theory of Relativity*, 117 ff. 222. *The Nature of the Physical World*, 237 ff.

56. Eddington, *New Pathways in Science*, 295 ff. Rutherford, Einstein, and Planck are cited.
57. Lemaître, "L'expansion de l'Espace," *Revue des Questions Scientifiques* (1931): 408.
58. *In I Perihemenias*, lectio 13, n. 10.
59. "The indeterminist is sometimes said to postulate 'something like free will' in the individual atoms. *Something like* is conveniently vague; the various mechanisms used in daily life have their obstinate moods and may be said to display something like free-will. But if it is suggested that we postulate psychological characters in the individual atoms of the kind which appear in our minds as free-will, I deny this altogether. We do not discard one rash generalization only to fall into another equally rash" (Eddington, *New Pathways in Science*, 66).
60. "Objectum autem intellectus est quod quid est, ut dicitur in III de anima, et propter hoc, actio intellectus extenditur quantum potest extendi virtus ejus ad quod quid est: per hanc autem primo ipsa principia cognita funt, ex quibus cognitis ulterius ratiocinando pervenitur in conclusionum notitiam: et hanc potentiam quas ipsas conclusiones in quod quid est nata est resolvere, Philosophus scientificum appellat. Sunt autem quaedam in quibus non est possibile talem resolutionem facere ut perveniat usque ad quod quid est, et hoc *propter incertitudinem sui esse*; sicut est in contingentibus in quantum contingentia sunt: unde talia non cognoscuntur per quod quid est, quod erat proprium objectum intellectus, sed per alium modum, scilicet per quamdam conjecturam de rebus illis de quibus plena certitudo haberi non potest" (*Q.D. de veritate*, q. 15, a. 2, ad 3).
61. *In I Sent.*, d. 38, q. 1, a. 5, c. See, too, Aristotle, *Metaphysics* VII, c. 3, 1078a8–15.
62. See Maritain, *Science et sagesse*, 67 ff.

ARE THE EXPERIMENTAL SCIENCES DISTINCT FROM THE PHILOSOPHY OF NATURE?



1941