Versions of Determinism

Joseph Agassi[1]

Abstract—Karl Popper's "Indeterminism in Quantum Physics and in Classical Physics" suffers unjust neglect. He judged determinism false: the future is open. In principle, replacing Laplace's variant of predetermination with predictable predetermination renders "scientific" determinism scientific and so refutable. Popper claimed that he had refuted it. Now a metaphysical system may have an extension—in the mathematical sense—that may render it explanatory and testable. If it exists, then it is not unique but has many alternative extensions. Popper's proof is then inconclusive.

Résumé—L'article de Karl Popper « Indeterminism in Quantum Physics and in Classical Physics » est tombé dans oubli injustement. Popper jugeait le déterminisme faux : l'avenir est ouvert. En principe, remplacer la variante de Laplace de la prédétermination par une prédétermination prévisible rend scientifique, et donc réfutable, le déterminisme « scientifique ». Popper a affirmé qu'il l'avait réfuté. Maintenant, un système métaphysique peut avoir une extension – au sens mathématique – qui le rend explicatif et testable. Si une extension existe, alors elle n'est pas unique, et de nombreuses autres extensions alternatives existent. La preuve de Popper n'est alors pas concluante.

Keywords—Laplace's Metaphysical Determinism, Popper, Determinisms, Indeterminism, Fault, Variant, Extension, Quantum Physics.

[1] **Jospeh Agassi**, Israeli philosopher, born 1927, editor of more than 10 books, author of more than 20 books and of over 600 papers in the learned press in diverse fields, chiefly in scientific philosophy and in politics. He studied with Karl Popper and taught at the London School of Economics. He then taught at University of Hong Kong, University of Illinois, University of Boston and York University in Canada. He had dual appointments in the last positions with Tel Aviv University. He believes that philosophy is nothing if not rationalist. For more than fifty years, he studied the rationality of science, metaphysics, and democratic politics. An advocate of Popper's philosophy with variations, Agassi ignores many of the problems that concern some philosophers of science, chiefly that of theory choice. The problems of the philosophy of technology engage him, including the problem of choosing scientific theories and ideas worthy of application and implementation.

1] An Outline

The attraction of determinism is in its avoidance of judgment. Heinrich Heine notes that Friedrich the Great had expelled Voltaire from his court for his view that soldiers do not deserve flogging, as they are mere automata. Popper responded to that story, saying, the monarch expelled Voltaire because he had no response to him, but there is a simple one: if they are automata, then I may flog them to my heart's content! The last word against determinism is that of Alfred Landé: it renders miraculous the possibility of any meaningful activity (like writing) since the laws of physics fully determine it and yet it also follows its rules (namely, grammar). This is overdetermination. The simplest example is from elementary algebra: values of n variables are fully determined by n independent equations; adding another independent equation makes it insoluble and the likelihood that the additional one will depend on the other is very slim.

2] Popper: *Indeterminism* and *Determinism*

Karl Popper's *Indeterminism in Quantum Physics and in Classical Physics* (Popper 1950, 1957, 1982, Agassi 1975) suffers unjust neglect. It discusses a variant of Laplace's determinism. Laplace offered a solution to a metaphysical problem: he wrote about probability that seems to clash with the determinism that he took for granted; is the clash real? The answer of Laplace is the subjective interpretation of the axioms of probability. All his life Popper argued against this interpretation and for a realist one.[2]

The preface to Laplace's *Philosophical Essay on Probability* of 1814 (Poincaré [1902] 1905) introduces an intellect—the literature refers to it as to "Laplace's demon"—armed with Newtonian mechanics, an image of the universe at any single moment, and an unlimited ability to compute. That intellect, Laplace declared, can

[2] Popper (Popper 1935, end of §27) declared that his methodology is open to both the subjectivist and the objectivist interpretation, and that his preference for the objectivist one is personal. In his preface to its 1959 English translation, he declared a change of mind: he viewed his position as objectivist and anti-subjectivist. The most challenging part of this reading was the chapter on probability. He made two great contributions here that he worked on for the rest of his life: he offered the first autonomous axiom system for probability, namely, a system that is open to all interpretations. Moreover, he developed the objectivist one, namely, his propensity interpretation of the axioms of probability.

know every past and every future event in the whole universe. This claim is Laplace's determinism; it is a version of "scientific" determinism. The discussion of determinism that followed the publication of his book centered on his version of it: obviously received opinion deemed it the best version. First, the versions of "scientific" determinism are all superior to religious fatalism — to the mere declaration that the future is predetermined — in that they appeal to science. Second, Laplace's determinism is a more detailed version of "scientific" determinism than that of Spinoza, as it appeals to a specific, highly corroborated scientific theory.

The first attack on the version of determinism of Laplace was mathematical; Henri Poincaré (Poincaré [1902] 1905) and Jacques Hadamard refuted some assumptions that Laplace had made about the power of mathematics. They refuted his assumption that in principle mathematics offers solutions to all the problems that it raises. Their just and historically very significant mathematical arguments are not relevant to this essay, that concedes the supposition of Laplace that in principle mathematics is complete—in order to examine the rest of his assumptions.

Popper judged determinism false: the future is open, he declared. His interest in determinism was to discredit it as much as he could, and mainly but not only for moral and political reasons: he viewed the thesis of historical inevitability a corollary to "scientific" determinism and he found it responsible for much political iniquity and moral irresponsibility.[3] He conceded that both the thesis of historical inevitability and "scientific" determinism are irrefutable and hence[4] possibly true. Replacing mere predetermination with a stronger claim, namely predictability in principle, and so of testability in principle, renders "scientific" determinism scientific and so refutable and then, Popper claimed, he had refuted it by the observation that already Henri Poincaré has made: it is impossible to

[3] Popper (Popper 1945, Ch. 13) rightly emphasized that it is possible to hold a metaphysical version of determinism and consider one's behavior as if determinism is false—as Spinoza did quite successfully and as Einstein did. Nevertheless, Popper also observed in that chapter, determinism did influence conduct, at least that of Karl Marx.

[4] Modal logic validates the inference from "*x* is irrefutable" to "*x* is possibly true". (Dummet 2011, p. 19) The verification principle denies meaning to the irrefutable and the possibly true. Its popularity at that time explains the neglect of Popper's discussion of determinism.

know our future predictions while keeping them in the future. Clearly, then, this observation of Poincaré (Poincaré [1902] 1905) proves inconsistent any Laplacian system that contains a predictor. It describes a universe containing a predictor able to predict every future event yet unable to predict at least one future event, namely, at least one item out of its own future behavior, namely, any future prediction of its own.

One might object to this line of thought: although you cannot predict your own future prediction, I can. This objection is easy to refute: a pair of predictors comprises a predictor, as is a community of predictors—since no limitation on the space that the predictor occupies is irrelevant here. True, when you and I try to predict the outcome of each other's prediction of each other prediction, the outcome is the same as any Popper-type short-circuit. J. W. N. Watkins (Watkins 1970) has adduced non-trivial and informative instances of Popper-type short-circuits, both in history and in game theory.[5] This sound too sophisticated; it seems we may exclude *ad hoc* self-prediction at least in the early stages of the discussion, as hardly possible anyway and so as scarcely relevant to the discussion of the impact of science on philosophy, and then ignore Popper's discussion. Not so: in his discussion of our inability to predict our own predictions Poincaré referred to our inability to predict the course of science; since science has tremendous and unforeseeable influence on our lives, no significant prediction of the human future is possible.[6] Yet, Popper admitted, determinism irrefutable. It is thus

[5] Cf. Watkins. Predictions that players make about each other's prediction about each other's conduct, refute the idea that full knowledge precludes risk (Watkins 1970, pp. 197-198). Extending this to the prisoners' dilemma refutes a basic assumption of some versions of traditional game theory (Watkins 1970, p. 206): it creates the situation—known from tense international borders—of an undesired Nash equilibrium of mutual distrust where the desired one is of mutual trust.

[6] Two examples. First, Marx used the fact that the efficiency of a steam engine increases with its size to predict the concentration of wealth due to competition, consequently the inability of the middle classes to compete with big capital, and thus their disappearance. Soon after he died, the new applicability of the electric dynamo and motor enabled the rise of the Edison Electric Company and its likes, and these enabled the creation of a new middle class of small entrepreneurs whose production depended on the available electric current. Second, Keynesian economic proposals prevented the allegedly ever-increasing misery due to economic crises that Marx deemed unstoppable, thus leading inexorably to the socialist revolution. Instead, this led to the rise of the welfare state that Marx had wrongly deemed impossible. It may be appropriate to mention science fiction here: Isaac Asimov's

possibly true. This situation he found disagreeable. There is one technique for handling such situations, already repeatedly illustrated in Plato's early dialogues: the disagreeable idea is too thin to be applicable; for this, it needs strengthening and its strengthened version is open to criticism. Popper undertook the task of enriching[7] Laplacian determinism so as to render it open to criticism and then to try to criticize it. The assumption that it is possible to perform this task raises the problem, then, as to whether other adequate extensions of the system are available. Still, let us first go over Popper's presentation of the situation. Popper's extension of the Laplacian system adds to it a Laplace-predictor, namely, the intellect of Laplace's initial description. Is this system, Popper asks, allowing the assumption of Laplace that our universe is determinist, is it still so after assuming that it contains predictors like you and me? (This addition of the Laplace-predictor to Laplace's system is the view that the intellect in his initial description of his system is an idealized version of Laplace himself.) The Laplace-predictor cannot perform every prediction, not the prediction that one Laplace-predictor should make about what another Laplace-predictor will predict. A Laplace-predictor thus cannot predict its own future prediction. This is a short circuit. To be able to prove his thesis, Popper replaced predetermination with predictability (within agreed limits of accuracy), which may be testable.

3] Popper's *Variant*

Popper claimed that his *variant* of the Laplace thesis is scientific, since it is inconsistent. This is an error: by his demarcation of science, a scientific system of statements must be:

Foundation (Asimov 1951) trilogy has its hero, Hari Seldon, made people in power forget his own prediction—to avoid defeating it.

[7] Diverse synonyms name enriching or increasing the content or the force of a system or extending it in the mathematical sense of the word. Popper notices in his *The Logic of Scientific Discovery* (Popper 1959, §15, Note *1), that the enrichment of a theory is self-understood. Incidentally, this he had to state since the reading of his book as a theory of scientific language—his protestation notwithstanding—renders highly problematic this rather intuitively admissible process. The extensions under discussion here are rather organic: otherwise, the mere conjunction of any two theories extends them. The reverse is also significant: of given variants of a given theory, Popper's methodology recommends the preference of the less informative but equally testable one (e.g., Mach's version of Newton's mechanics minus its assumption of the existence of absolute space).

(a) consistent

and

(b) inconsistent with at least one conceivable[8] observation report.

Hence, by Popper's own criterion of demarcation of science, his variant of the system of Laplace is unscientific. Hence, at most Popper has shown that "scientific" determinism is impossible; he has not refuted the metaphysical thesis extended to be scientific *à la* Popper, as he had not constructed one. (His extended version adds too much.)

A metaphysical system may have an extension — in the mathematical sense — that may render it explanatory and empirically testable. The paradigm case for this is the case of atomism, ancient and modern, as these are metaphysical and scientific respectively.[9] All sorts of writers[10] have taken for granted the ability to render metaphysics scientific, including those most hostile to metaphysics. Thus, when members of the Vienna Circle dismissed theology as meaningless on the ground that the Holy Name does not designate clearly, they explained that had it clearly and unequivocally designated, say, the column of fire that supposedly went before the Children of Israel in the desert (*Exodus*, 13:21-22), then they would consider assertions about the Divine false, not meaningless. The method of extension, however, is in great neglect. The characterization of metaphysics remained for long unstudied, although repeatedly some commentators took it for granted that metaphysics is a

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[8] The metaphysics of Parmenides is refutable, as already Antisthenes has claimed (by moving back and forth). Parmenides would not admit the refuting observation, and Zeno tried to prove him right on this. To meet this, Popper replaced the requirement for tests with the requirement of admissible ones: he allowed for the conventionalist's refusal to admit the possible refutation of a significant theory, and offered in opposition to it the convention to avoid the apologetic rescue of a theory. This convention will nullify Parmenides theory as scientific but not as a metaphysics. This is important since that theory led to the atomism whose importance is beyond contest. See Popper 1953.

[9] Admittedly, a theory can have metaphysical and scientific readings. Thales theory does, since water is decomposable and since Einstein has demolished the substance theory.

[10] The literature on this item is immense. It is all elaborations on Wittgenstein "[…] whenever someone else wanted to say something metaphysical, to demonstrate to him that he had failed to give a meaning to certain signs in his propositions". (Wittgenstein [1921] 1922, §6.53) For, they all took for granted his "what can be said at all can be said clearly, and what we cannot talk about we must pass over in silence" (Preface). This is a false assertion and an objectionable demand.

system of general suppositions for science, and thus a general outlook or a general framework or a worldview of sorts.[11] Ludwig Wittgenstein declared high-handedly that all efforts to state metaphysics in sufficiently clear statements are impossible. He thereby blocked all effort to characterize metaphysics.[12] Popper's early publications characterized scientific systems (not sentences); ignoring here logic and mathematics, as the status of these is uncontested, he advised disregarding all non-science, including systems of superstition, of religion, of metaphysics, and of pseudoscience, calling them all "metaphysical" even though they clearly differ from each other in many respects. He noted that metaphysical systems such as ancient atomism have heuristic value (Popper 1935, §4, §78, §85 and Appendices) but while insisting there on leaving aside all heuristic. After his famous clash with Wittgenstein, he discussed the problems that philosophy (metaphysics) comes to answer as rooted in scientific theories (Popper 1952). These problems appeared there as cosmological, namely, in search of a worldview, and in this study of his ancient atomism played a major role.

4] Popper's *Extension*

Some metaphysical systems may not be open to "natural" (see below) extension, much less to scientific ones. What is necessary for it? Popper has constructed one trivial extension of an obviously untestable system to a testable one: a system containing one purely existential statement—there exists a mermaid—may become testable by the addition to it of space-time specification—a mermaid is now present in the neighborhood aquarium. Rudolf Carnap has suggested that this cannot hold for statements with universal and existential quantifiers (as if this makes any difference for this example to be a refutation of his system). Watkins called these "all and some statements" and refuted Carnap's suggestion by an example. His example is, "everyone has a soul mate": it is untestable and a specification of it, "everyone is married to one's soul mate", that is a scientific extension of it, and that is refutable (and refuted). Now "every event has a cause" is metaphysical determinism; Popper's

[11] A metaphysics is of science in general and, by courtesy, of any specific science (Agassi 1977, Ch. 1, note 21).

[12] Nevertheless, Carnap characterized metaphysics as the confusion between language and metalanguage. Atomism refutes this proposal.

extension of it to "every event is predictable from its cause" is refutable. It is, but, by Popper's own magnificent theory of scientific character, to be scientific a theory must be both consistent and empirically refutable; yet, as he has claimed, his extension of determinism is inconsistent. Popper's *extension* of determinism by specifying decidability to predictability achieves its aim of making it unattractive. His view of it as scientific was a technical error. Still, this leaves open the question, is there a possible "natural" extension of determinism (not by rendering it predictable but) by adding to it another qualification that would enable it to depict some event as (erroneously) predictable? If there were such an extension, then there would be no reason to assume that it is unique. Moreover, the determinism could be subject to many alternative extensions. Then there would be no reason to assume that this holds only for determinism and not for any other metaphysics. Indeed, ancient atomism underwent extensions into diverse scientific theories–all of them refuted by now.[13]

Traditionally, metaphysics was not just the presuppositions for (some) science but also what claims some comprehensiveness in some intuitive sense of the word. Take the metaphysical system of Newton's *Principia*, namely, Euclid's space populated with point-masses interacting with central forces (namely, with forces that obey his famous three laws). It is metaphysical and it is untestable. Adding to it his law of gravity (or Coulomb's law of electricity) will yield a testable system *par excellence,* and this is an extension in the obvious sense of specification (of the laws). It is not necessarily an extension in the strict ("natural") sense of being comprehensive. The view, once quite popular, of it as possessing one and only one force (the idea that all forces are reducible to one) is comprehensive and so it is more "natural" an extension of the theory that renders it a metaphysics proper. Another possible extension of it would be a list of the forces governing the system of the world, plus the claim that the list is complete, namely that all known phenomena are in principle thus explicable. (An alternative is to list all the possible forms of energy; deciding that the list is complete makes the law of conservation of energy comprehensive and thus refutable, as

[13] To be precise, the initial version of atomism is not as thin as the enriched one. This, however, is understandable. We do not have the full ancient story; quite possibly Democritus distinguished between the thinnest version of his doctrine and the thickest version that he could (and intended to) generate.

Poincaré noted (Poincaré [1902] 1905, Ch. 5) he advised against this—to escape testability). Any scientific theory, such as Newtonian theory of gravitation that conforms to Newton's metaphysics, is a possible part of the "natural" extension of it. This proves that if Newton's metaphysics can undergo extension its extension is not unique, even if its "natural" extension may be. The claim that an extension need not be unique is commonsense. Hence, the onus of proof is on anyone who claims uniqueness. Hence, in principle, what extension is "natural" or comprehensive is unclear.

5] Conclusions

The fault with Popper's extension of Laplace's metaphysical determinism into scientific version is the tacit but very clear claim for uniqueness: Popper took it for granted that he had refuted all possible scientific versions of determinism. Now, supposing Newtonian metaphysics were extendable to a scientific system, and suppose, with Laplace, that all problems within it have unique solutions, then, clearly, each such extension is already both deterministic in Laplace's original sense, predictable in principles and scientific as refutable in principles.

To put it generally, when a metaphysics has a set of scientific theories that conform to it, and we add to that set the claim of completeness, then the metaphysics evolves into a scientific system (Agassi 1964). Here scientific character is considered a refutable explanation; if one wants refutability alone, then it is much easier to extend a metaphysics that has some scientific theory conforming to it: one can simply claim completeness anyway and have the completeness claim trivially refuted. Also, metaphysics is here taken in the traditional sense, not in the (much broader) Wittgenstein-style sense or Vienna Circle-style sense, in which "non-science" and "metaphysics" are synonyms. In this sense, determinism is not a metaphysics proper. It is nonetheless metaphysical, as it is a character in some metaphysical systems.

To put all this most generally, there is still no consensus about the traditional dispute within philosophy between intellectualism and empiricism, although most philosophers of science are empiricists. Historically, this was the verdict of Laplace: the scientific choice between the Cartesian and the Newtonian systems of the world was also the methodological choice between the intellectualists and the empiricists; and when Newton won, he won on both

fronts. Nevertheless, the metaphysics of Descartes fascinated Laplace sufficiently to try a system of the world (with *fluide gravidique*) that should comply with both Descartes' and Newton's systems. He never tried his hand with the parallel system that should comply with both Descartes' and Newton's methodologies. The idea that a theory has both an empirical base and an *a priori* justification looks either encumbered with redundancy or a matter of course. For, logically, the idea of redundancy is that the redundant item follows from the rest. It is easy to see that neither intellectualism nor empiricism entails each other. At most, both justify the same system, yet not very likely. This would be a serious impediment for classical methodology that requires proof; not for Popper's system, as it requires openness to criticism. In this sense, Popper's extension of Laplace's "scientific" determinism is in line with his methodology, but this does not mean that his extension is the only one possible; hence, we have so far no refutation of all possible, reasonable versions of "scientific" determinism.

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