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THE IMPASSE OF PLANCK'S EPISTEMOLOGY

Classical physics emerged in a context of explicit epistemological presuppositions. They were put forward —it is enough to think of Galileo's evaluation of the respective merits of primary and secondary qualities and of Newton's unabashed Cartesianism in the Queries of the *Opticks*— in a tone which suggests not only the bearing of physics on epistemology but a radical subordination of epistemology to physics. About the emergence of modern physics few beliefs have become more widespread than the one according to which quantum theory and relativity have revolutionized not only physics but epistemology as well. No small role has been played in that respect by headlines, often inspired by statements of prominent physicists. The headline, «Physicists redefine reality», in the August 25, 1981 issue of *The Economist*, could hardly have been more epistemological[1]. Quite a few physicists believe that they can do with reality much more than redefine it. That material reality is the product of space-time geometries and that even the whole universe issued out of a non-commutative algebraic operator, or, more picturesquely, out of a mere quantum flip are the not-too-esoteric forms of some prominent physicists' belief that reality is the product of their mind.

The ability to produce reality by mere thought, and even the mere competence to redefine reality, would more than ensure the superiority of physics over epistemology. All important as such a superiority may appear, it may not be referred to in contexts which deal with the professional advancement of a physicist. In today's frantic race for prestigious chairs, research grants, memberships in scientific academies, let alone for a Nobel Prize (and even for a quantum, that is, a half, a third, or a mere fourth of it), among the qualifications advanced on behalf of a physicist none would do with the pre-

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1. The headline was prompted by the experiment performed in the laboratories of the University of Paris at Orsay by A. Aspect and his co-workers in 1981. The experiment disproved a prediction of the so-called hidden-variables, theories which claim that absolutely precise measurements of conjugate variables are possible, in principle at least, on the atomic level. To the credit of the article in *The Economist* (p. 95) it was pointed out there that a Pandora-box might open by siding with the opposite view, which usually implies the philosophy that a thing exists only when it is being thought of.

sumed epistemological value of his work. The pattern, a clear evidence of professional purism, is not at all new. It played a part in the process which saw most physicists quietly discard their erstwhile title, «natural philosophers». Planck clearly broke the rules of that purism when in 1910 he urged the Prussian government that Einstein be made a member of the Berlin Academy partly because of his work's bearing on epistemology[2].

Nothing is more tempting than to look for explanation in the cultural and social context for Planck's departure from unwritten rules. In a Prussia, which almost a hundred years earlier almost begged Hegel to accept the chair of philosophy in Berlin so that the spirit of the nation might thereby be redressed and reinvigorated[3], philosophy elicited greater awe than elsewhere in the Western World. Philosophy further gained in esteem in that newly-formed Reich which strove to put German intellectual and scientific heritage on a pedestal comparable to French and British grandeur. The effort was highly successful even abroad. It became a byword in the Third Republic that German schoolmasters were ultimately responsible for the outcome of the war of 1870. As to Britain, its leading philosophers around 1900 did not like to recall, as noted by William James, the incomprehension which their predecessors professed with respect to Kant[4]. American colleges, eager to become universities, sent their younger faculty above all to Germany to learn the art of scolarship and looked at Lotze, who launched Neo-Kantianism, as the leading spirit of the day. In the First Reich the rise and flourishing of Neo-Kantianism, which reached its zenith around 1910, was an aspect of the creation of a pantheon of the heroes of the German mind.

Although Planck was an unabashed patriot who, as will be seen, shared his time's admiration for Kant, his attention to epistemology, of which his recommendation of Einstein was a proof, had roots more personal than social. More than thirty years earlier Planck, who could have made a good career as a mathematician or as a musician, chose physics precisely because physics appeared to him as the most effective tool for securing a solid Weltanschauung. The choice was all the more personal because young Planck was emphatically advised by a noted physicist against choosing physics for a career. He would have undoubtedly met with sligt ridicule had he disclosed his budding con-

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2. For excerpts from that document, see R. W. Clark: Einstein: *The Life and Times* (New York: Thomas Y. Crowell 1971), p. 169.

3. See F. Wiedmann, *Hegel. An Illustrated Biography,* translated from the German by J. Neugroschel (New York: Western Publishing Co. 1968), pp. 53-54.

4. W. James, *A Pluralistic Universe* (New York: Longmans, Green and Co. 1909), p. 5.

viction that physical research, if done properly, could lead to the 'absolute'[5]. Indeed, around 1880, when Planck, aged twenty-two, stood between his doctorate and his Habilitationschrift, a quest for the 'absolute' could not find much echo with German scientists. They for the most part were engaged in research geared to technological application or in experimental tours de force aimed at greatly increasing the precision of measurements. The latter attitude was facetiously embodied in Kohlrausch's often-quoted readiness to measure with perfect accuracy anything, be it the flow of rainwater in the gutter[6], hardly a venture issuing in epistemological reflections. The relatively few physicists interested in theory sided with Kirchoff's methodical positivism which again was no prompting for pursuing philosophy and Weltanschauung unless in the sense of putting both beyond the pale of intellectual respectability, or, at best, keeping them as objects of courteous lip service. Even in that form philosophy was resented by Ernst Mach, who from the 1880s on exerted an increasing influence on German physicists. He never failed to urge that, in constructing physical theory, they should consider only what was directly observable, that is, sensory, and in that sense non-metaphysical.

Within such a professional milieu Planck's ambition to reach the 'absolute' through physics had to appear something to be kept to himself. Nor did he seem to have any clear idea at that time as to what was implied philosophically by that search for the 'absolute'. During his years in Kiel (1885-89), which started his professional career, he felt that his research program was compatible with Mach's philosophy[7], a judgment hardly indicative of philosophical or epistemological perspicuity. While within a decade or so he had fully cured himself of Machism and opted for Kant, for whom he kept a deep reverence to the end, he never wanted to appear in the mantle of a philosopher. He firmly believed that it was as a physicist that he had waged a crusade during his last forty years on behalf of the 'absolute', by which he often meant an objective universe. In a much deeper sense than he suspected, he was right in his belief.

Had Kantianism or Neo-Kantianism been effective in inspiring commitment to the 'absolute', Planck would not have felt the need for a crusade on

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5. See the opening paragraph of «Wissenschaftliche Selbstbiographie» in M. Planck, *Physikalische Abhandlungen und Vorträge* (Braunschweig: Friedr. Vieweg & Sohn, 1958), vol. III, p. 374. The physicist in question was Philipp von Jolly, professor at the University of Munich.

6. Such was Kohlrausch's comment on a remark of A. Kundt. See my *The Relevance of Physics* (Chicago: University of Chicago Press, 1966), p. 237.

7. «Zur Machschen Theorie der physikalischen Erkenntnis», *Naturwissenschaften* 11 (1910), p. 1187.

behalf of an ideal form of physics, a crusade above all aimed at the world of physicists. That crusade forms part of a story, which stretched from Planck's initial commitment to the physical absolute through his weening himself from antirealist (Machist) theories of physics to his campaign on behalf of an absolute causal order in nature, which in turn was the background of Planck's final grappling with a subtly personal Absolute. It is a story in which Planck's commitment to his notion of the ideal form of physics (science) and his scientific creativity acted as principal motivation, a story told elsewhere[8]. The story shows all too well that taking physics for epistemology calls for the same unlimited play of the force of logic that is displayed time and again in major philosophical systems. Once objective reality was given a recognition in Planck's unconditional manner, a specific train of thought exerted itself, even though some philosophical presuppositions, incompatible with that recognition were simultaneously at work. Had Planck, the epistemologist, been fundamentally a Kantian and a consistent one, he would have by instinct reached Kant's conclusion that God was merely an idea within him[9], precisely because the universe as spoken by Kant was but such an idea. But the universe, being supremely objective for Planck the physicist, not only prevented him from being trapped in an idealist ego, but also made him, in the long run, move beyond the universe. This thrust of a truly objective universe is noticeable in most varied and telling contexts. It should seem telling indeed that a Henry Adams, who was raised in an ambience which «solved the universe so thoroughly» that none of the major problems that agitated mankind since times immemorial seemed «worth discussing», came to recognize that if he «were obliged to insist on a Universe, he seemed driven to the Church»[10]. Einstein for one felt the need to ease with the remark, «I had not yet fallen in the hands of priests», the anxiety of a friend who worried about a possible theological impact on Einstein of his cosmological thought[11].

Not so far reaching is, of course, the central problem for Planck the epistemologist to be considered here. In a superficial sense, the problem is the extent to which Planck should be considered the founder of modern physics. Nobody would call in doubt that he was the first to enunciate in 1900 the

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8. In ch. 11, «The Quantum of Science», In my Gifford Lectures, *The Road of Science and the Ways to God* (Chicago: University of Chicago Press 1978).

9. *Kant's Opus postumum*, edited by A. Buchenau (Berlin: Walter de Gruyter 1938), vol. 1, p. 145. There Kant also spoke of man as a being that was God himself (p. 25).

10. H. Adams, *The Education of Henry Adams* (1918), with an introduction by J. T. Adams (New York: The Modern Library, 1931), pp. 34 and 429.

11. *Lettres à Maurice Solovine* (Paris: Gauthier-Villars 1956), p. 115. The letter was written on March 30, 1952.

notion of the «quantum of action» as a universal and real feature of the physical world. Yet it fell to others (Heisenberg, Schrödinger, and Born) to construct around 1926 the science of quantum mechanics, which in view of its enormous success was once described by Schrödinger as «the Lord's quantum mechanics»[12]. Planck was not the first to propose something much less, namely, the propagation of electromagnetic radiation in quanta and, contrary to the stereotyped view, he was not even the first to propose its quantized emission or rather generation. His theories of black-body radiation, of which he offered at least two major versions between 1905 and 1920, did not imply a break with classical concepts[13]. Within the framework of those theories, to quote a remark of his from 1905, «the introduction of the *finite* energy quantum h is an additional hypothesis, foreign to the... theory»[14]. In fact, for all his pride in discovering h and for all his firm belief in its physical and universal significance, he was never at ease with it. «I hate the discontinuity of energy», he wrote in 1915, «even more than the discontinuity of emission»[15].

In his Nobel Prize acceptance speech, delivered in June 1920, there was a distinct touch of pleasure mixed with apprehension. He could but register his satisfaction over the fact that the «quantum of action» made possible the explanation of phenomena ranging from the photoelectric effect through the variation with temperature of the specific heat of solids, to the vast world of spectral lines. That not he but others were responsible for all those feats was acknowledged by him with a generosity untainted by any trace of jealousy. His apprehension related to what in his eyes was a very great price to be paid for all that his discovery led to. The quantum of action was imposing the need to recast «physical ideas which since the foundation of the infinitesimal calculus by Leibniz and Newton, were built on the assumption of continuity of all causal relations»[16]. Planck here could but think of the fact that he derived his famous formula not through «integrating» the various modes (energy states) of ideal resonators but through the processs of «summation». The latter foreclosed that mathematical continuity which is implied in infinitesimal calculus of going to the limit.

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12. E. Schrödinger, *What is Life and Other Scientific Essays* (Garden City, N. Y.: Doubleday 1956), p. 83.

13. As shown by T. S. Kuhn, *Black-Body Theory and the Quantum Discontinuity 1894-1912* (Oxford: Clarendon Press 1978), p. 132.

14. Letter of July 6, 1905 to Ehrenfest: quoted *ibid.*, p. 132.

15. Letter of May 23, 1915 to Ehrenfest, quoted *ibid.*, p. 253.

16. «The Origin and Development of the Quantum Theory», (June 2, 1920). See English translation in M. Planck, *A Survey of Physics*, translated by R. Jones and D. H. Williams, (London: Methuen 1925), p. 109.

The quantum of action, which emerged on the horizon in 1900, was by 1920 no longer a new element to be fitted into a structure with hardly any change in it. After two decades of proving its immense usefulness, the new element was requiring the undermining of the structure itself. To Planck's brooding question, «at what place and to what degree will this happen?», physics gave an answer within half a dozen years, an answer that became the accepted view, a dogma, to almost all concerned. The nature of the answer was foreconditioned in that phrase of Planck about «the continuity of all causal relations», a phrase much more significant than Planck would have suspected. Therein lies the source of the problem which became an insoluble impasse in Planck's epistemology as well as in the prevailing epistemological interpretation of modern physics. The chief instructiveness of Planck's epistemology lies in that connection.

In speaking of Planck's epistemology several reservations are in order. They are imposed by the fact that Planck was not a philosopher, not even a serious student of philosophy, but a working physicist. As in the case with almost all physicists, Planck did not work out a philosophical system. His only detailed and fairly systematic articulation of philosophical (epistemological themes is an address he gave on February 17, 1923. By then he was in his 65th year, hardly the age to start in philosophy or anything else. The address, a long public lecture delivered in the Berlin Academy of Sciences on causality and free will[17], is still to be given its due by historians of the philosophy of modern physics. Planck worked into that lecture philosophical considerations which he had voiced briefly in the previous fifteen years in half a dozen lectures that dealt with the ideal form of physical science in the light of new discoveries and advances[18]. The same lecture also contained several new philosophical reasonings which Planck later reitereated with minor variations. Analysis and appraisal of the lecture are helped by its simple structure and, last but not least, by the clarity of Planck's style which is often presented as model of exposition.

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17. An almost complete, though in places somewhat free translation of that address, «Causation and Free Will», is given in M. Planck, *The New Science* (New York: Meridian Books 1959), pp. 65-122. The German original, «Kausalgesetz und Willensfreiheit», is readily available in M. Planck, *Vorträge und Erinnerungen* (Darmstadt: Wissenschaftliche Buchgesellschaft 1965), pp. 139-68.

18. Their English translation is available in *A Survey of Physics* quoted above (note 16). The most important of them is the lecture, «The Unity of the Physical Universe» (Die Einheit des physikalischen Weltbildes»), which Planck delivered at the University of Leiden on December 9, 1908, and in which he made a frontal attack on the subjectivism implied in Mach's sensationism.

The starting point of the lecture was the plain admission on Planck's part that his reason to discuss the topic derived from his interest in physics and especially in its reliability as the most exact of all sciences. It cannot be emphasized enough that Planck was interested in philosophy only insofar as the cultivation of physics called for philosophical reflections. Moreover, and this is a no less important point, about physics Planck had a very definite idea. It was by no means an original idea with him. Long before him (it is enough to think of Galileo and Newton) many physicists held that the essence of physics was the investigation of causal processes taking place in a physical universe existing independently of the physicist's reflections. Of course, by the time Planck came to the scene a philosophy of mechanistic causality was no longer an invariably shared part of the physicist's conception of his work. Formalism, positivism, economism, and even mere commodism (it should be enough to recall the names of Lagrange, Kirchoff, Mach, and Poincaré) were receiving more and more votes from leading physicists. The thermodynamics of irreversible processes invited antimechanistic views, a point articulated with great persuasiveness by Duhem[19]. Mechanists or not, physicists were at one in stressing the ability of physical theory to predict future occurrences, an ability which Planck emphatically took for the evidence of mechanistic causality. He was fond of referring to that ability with a reference to that superior spirit to whom, as Laplace once memorably stated, no future physical event would be hidden because all physical parameters determining the present were fully known to him. While in Laplace's rendering that knowledge of the future was restricted to physical events, in Planck's version (and this should be indicative of his commitment to mechanistic causality) it included all mental phenomena and even the acts of will[20].

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19. Both in a series of essays on the philosophy of physics published during his years in Lille (1887-93) which he later worked into his *La théorie physique: son objet et sa structure* (1906; English translation, *The Aim and Structure of Physical Theory,* 1954), and also in some of his technical publications, such as his «Commentaires aux principes de la thermodynamique» (1892-94) and especially his *Traité d'Energétique* (1911). For details, see my book, *Uneasy Genius: The Life and Work of Pierre Duhem* (Dordrecht, London, Boston: Martinus Nijhoff/Kluwer 1984).

20. «Causation and Free Will», *The New Science,* p. 116. Planck explicity referred to Laplace in the same context. Laplace was clearly echoed in the opening sentence of Planck's address, «The Principle of Least Action» (1914); see *A Survey of Physics*, p. 69. In speaking in 1935 in his «Die Physik im Kampf um Weltanschauung» (English translation, «Physics and World Philosophy») in M. Planck, *The Philosophy of Physics,* translated by W. H. Johnston (New York: W. W. Norton 1936, pp. 24-26) of the subjection to strict physical laws of every bubble in waves breaking on the seashore, Planck may have followed a rephrasing of the Laplacian theme by T. H. Huxley in his reminiscences on the reception of

Defense of the reliability of physics amounted therefore to a defense of causality. Such was even in Planck's admission a narrow perspective. He should have rather referred to its shallowness, and all the more so because he could see merit in viewpoints of distinctly greater philosophical depth. Thus he did not dismiss out of hand the view that «philosophy must precede every special science» and that it was contrary to the dictate of reason «if one of the special sciences were to take up the treatment of general philosophical question»[21]. There could, however, be no point in retaining some measure of competence for philosophy in connection with causality if it was true that causality could not be vindicated by philosophy of which Planck recognized only an abstract (rationalist) and an empiricist version. An impasse was therefore in sight already at the end of the first part of Planck's lecture where he gave a survey of the problem of causality in those two schools of thought which for him represented *all* philosophy. He knew not of a third school, a school of philosophical realism, a school called for by that emphatic assertion of Planck that by causality he meant above all causality in the *real* world[22]. The business of reality rested in Planck's eyes with physics alone. The narrowness of this view was intimated by the fact that what he asked from philosophy was not so much a proof of the fact of causality, but whether causality could be scientifically ascertained in all circumstances, and on all levels. Clearly, what Planck wanted to secure was a very narrow aspect of causality implied in a very specific type of physics whose exclusive validity was by 1923 threatened not only by statistical mechanics, but even more so by considerations which the emission and propagation of electromagnetic radiation in the form of quanta kept inspiring.

Planck's spirited attachment to that very specific if not oblique sense of causality (strict predictability of future events, in each and every case, by the methods of mathematical physics) was hardly an invitation to philosophy. That he could not see philosophy as the source of answer to the question of causality could also be gathered from his conclusion that causality was not a necessary element of human thought. He reached that conclusion on the ground that the human mind could imagine all sorts of contradictory and non-causal situations, non-sequiturs, and sheer fantasies. It wholly escaped Planck that if this proved anything, it proved only that the mind was more

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Darwin's theory. See *The Life and Letters of Charles Darwin,* edited by F. Darwin (1888; New York: Basic Books 1959), vol. I, pp. 553-55.

21. «Causation and Free Will», in *The New Science,* p. 88.

22. *Ibid.*, p. 71.

than a mere logic machine and that this alone secured the possibility that he himself could take such a look at the question of causality which was not a predetermined series of reasonings and therefore a meaningful topic to consider.

Planck the philosopher hardly distinguished himself as he surveyed the answer of philosophies to the specific question whether causality was unrestrictedly valid. The rationalist or deductive approach to causality he saw exemplified in the Greco-Scholastic school, in Descartes, in Spinoza, and in Leibniz. Planck seemed to be satisfied with at least that aspect of Spinoza's system according to which the divine was identical with everything to such an extent as to exclude the possibility that even a miracle might break the chain of causality. That the Spinozean system did not allow for the existence of particular things, the very things which physics was supposed to investigate[23], was not considered by Planck. About Leibniz, Planck remembered only his monadology without warning that monadology foreclosed interaction (and therefore causality) among individual things, so many monads or strictly isolated entities, in ultimate analysis. Planck did not as much as hint about the realist strain in Leibniz, a strain harking back to Leibniz's familiarity with some of the very foundations of Scholastic philosophy, which prompted his famous question: «Why is there something rather than nothing?»[24] Planck's rendering of Descartes makes one wonder whether Planck knew of him except by hearsay. He stated as Descartes' starting point that the universe was God's free creation and therefore miracles were possible. Such a rendering was certainly characteristic of Planck's deep uneasiness about the breaking of the causal chain but rather distortive of Descartes' philosophy, the essence of which was that God had to create (if he created at all; Descartes the philosopher was very different from Descartes the Christian) the actually existing world because one could, through Descartes' method, convincingly derive its main features from a priori considerations[25].

As to Planck's rendering of «Greco-Scholastics», one has to be somewhat indulgent though not overly. Planck was the product of a cultural ambience

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23. The problem was brought to Spinoza's attention by Tschirnhausen. For their exchange of letters, see *The Chief Works of Benedict de Spinoza,* translated from the Latin, with an introduction by R. H. M. Elwes (1893; New York: Dover 1951), vol. II, p. 408-09.

24. «The Principles of Nature and of Grace, based on Reason» (1714); see *Leibniz Selections,* ed. Philip P. Wiener (New York: Charles Scribner's Sons 1951), p. 527.

25. This is why Descartes had to insist in the *Discourse on the Method* that his procedure did not do «outrage to the miracle of creation»; see *The Philosophical Works of Descartes*, tr. E. S. Haldane and G. R. T. Ross (Cambridge University Press 1911), vol. I, p. 109.

in which the precept, *catholica non leguntur* (books written by Catholic scholars need not be read), was voiced even by such luminaries as Harnack, Planck's predecessor as perpetual secretary of the Berlin Academy. By 1923 Neo-Scholasticism in Germany produced not only a vast number of meticulously documented historical studies of scholastic philosophy but also some high-level popularizations[26] which gave so many lies to Planck's assertion that «in the historical rationalist school» (Scholastics) one was faced with a «hybrid attempt of fusing the Greek Prime Mover of Aristotle with the Hebrew Jehovah so that room might be left for supernatural intervention in the causal chain»[27]. That Yahweh was the ground of existence for the Scholastics rather than a mere Prime Mover was a notion that did not seem to have ever come within Planck's ken. He opined that in the Scholastic outlook the First Being was a mere replica of the visible world, so that, to quote Planck's words, «the concept of the Divinity in this case must take its color from the world-outlook either of the individual philosopher in question or of the particular cultural background to which he belongs»[28]. The statement clashed head-on with the insistence of all great Scholastics, and certainly with the insistence of Thomas and Scotus, that all knowledge, natural and supernatural, about God is essentially negative[29]. Had Planck informed himself, however modestly, on Scholastic philosophy, he might have seen that the Scholastics, precisely because they believed in creation out of nothing, could extricate even physics from an impasse where it was left by the insistence of Aristotle and other Greek philosophers on the unbrokenness of causal chain, an insistence which Planck tied to their espousal of the principle *ex nihilo nihil fit*[30].

Planck's lack of interest in the question why the chain itself existed was an all the more revealing feature of his epistemology because he rallied to the defense of objective reality long before Einstein himself was driven to a staunch

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26. The chief organ of those studies was the series *Beiträge zur Geschichte der Philosophie des Mittelalters* (Münster i. W.). Among the authors of such popularizations were M. Grabmann and C. M. Manser. Even a study of post-World-War-I editions of F. Ueberweg's *Grundriss der Geschichte der Philosophie,* a work which by then had long established itself as a classic, could have given to Planck a far better view on scholastic philosophy than the one he set forth.

27. «Causation and Free Will», pp. 75-76.

28. *Ibid.*, p. 75.

29. As emphatically argued by no less an expert on Thomistic philosophy than E. Gilson in his *The Spirit of Thomism* (New York: P. J. Kennedy & Sons 1964; Harper Torchbooks 1966), pp. 77-78.

30. For details see my *Cosmos and Creator* (Edinburgh Scottish Academic Press 1981), pp. 73-75.

espousal of the realist position. Planck was a realist not as a philosopher but as a physicist. He failed to perceive that a realist philosophy was implied in his penetrating evaluation of the empiricists' handling of causality. Useful as the empiricist school was in breaking with what Planck called the naiveté of the rationalist school, and oriented as it was toward science, it was nevertheless trapped in solipsism. Sensations, Planck insisted, were entirely subjective and did not entitle one to deduce the existence of an object. The succession of sensations could in no way be construed as an evidence of objective causality, because the force of habit did not in itself explain why the attribution was to be made at all. The empiricists (whether represented by Locke or Hume) could not, Planck remarked, logically argue that their dreams were different from their thinking while being awake. Of course, the empiricists could and did fall back on common sense, but it was not something which they could invoke on the basis of strictly logical inferences starting from the initial presupposition that sensations were the sole primary data.

As one might expect, Berkeley's method of escaping from the solipsism of Locke's sensationism did not find favor with Planck. For one thing, the method was not tailored for ordinary material reality, for another, it was contrived to make possible miracles, so many breaks in the causal chain which Planck could not countenance. Quite different was Planck's appraisal of Kant. Whatever the arbitrariness and dogmatism of some of Kant's assertions, his teaching was «useful and conclusive in most of its results», so Planck declared[31]. Such was a position typical of a Neo-Kantian who preferred to ignore all those results of Kantian philosophy which made themselves fully felt in Kant's *Opus postumum*. About the thousands of manuscript-pages making up that work, discovered in the 1880s, the standard view then as now was that they were mere jottings by an increasingly senile Kant and not an integral part of the task which Kant had set for himself. The «critical» viewpoint which Kant implemented for metaphysics (*Critique of Pure Reason*) and extended to ethics (*Critique of Practical Reason*), esthetics (*Critique of Judgment*), and afterwards to pedagogy and theology[32], had to be spelled out

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31. «Causation and Free Will», p. 86. It is difficult to see how this could be true if it was also true that «Kant's teaching... is to a certain extent arbitrary on account of its strong dogmatic attitude» (*Ibid.*). This inconsistency was compounded by Planck's subsequent reasoning which stated the need for metaphysics if one was to avoid solipsism, but which also stated the need to accept a certain measure of compromise with logic, because in order to save causality one had to remain somewhere in the middle between metaphysics and empiricism.

32. The works relating to those last two fields have been translated into English under the titles, *Kant on Education* and *Religion within the Limits of Reason alone*.

in detail also for the sciences if «critical» philosophy was to obtain its ultimate touchstone of truth. The result was sheer horror, Naturphilosophie[33], about which Neo-Kantians preferred the strategy of silence. Planck, and this should be indicative of his uncritical Neo-Kantianism, never referred to that aspect of Kant's system, nor did he refer to Naturphilosophie as practiced by Kant's successors, Schelling, Hegel, and others, although it was the target of very critical and well known remarks by such prominent German physicists as Gauss and Helmholtz[34].

According to Planck, Kant was the first to point out that in addition to sensations, there was another source of knowledge, the categories, among them causality, independent of all experience. Causality, conceived in such a way, imposed on the human mind the recognition that anything that happens presupposes something from which it follows according to a law. Such was Kant's way, as Planck put it, «to jump the wall separating the senses from reality at some part of it, preferably at the beginning». The jump was metaphysical and Planck readily admitted that «we cannot avoid metaphysics if we are to save ourselves from falling into the deadlock of solipsism»[35]. But to what extent did Planck need metaphysics? Without spelling out the weak aspects of Kant's metaphysical jump to reality, he stated that they could be «strengthened for all *practical* purposes» (italics added) and thus a compromise (obviously epistemological) could be worked out[36]. That compromise was in substance the pragmatism contained in the *Critique of Practical Reason*. That it did not differ at all from the positivists' justification of causality on the basis of its «usefulness» wholly escaped Planck as he closed his survey of the philosophical efforts to do justice to causality. The grand conclusion of that survey was that «the nature and universal validity of the law of causation cannot be definitely decided upon any grounds of purely abstract reasoning»[37]. Clearly, Kant could be retained only as the author of *Practical Reason*. Planck's statement that «the transcendental and positivist viewpoints are irreconcilable and they will remain so as long as the race of philosophers lasts», could not therefore be construed in the sense that the transcendental viewpoint was right, however undemonstrable, even if this was what he meant.

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33. A. E. Adickes, *Kant als Naturforscher* (Berlin: W. de Gruyter 1925), vol. II, p. 204.
34. For details, see my *The Relevance of Physics,* p. 334.
35. «Causation and Free Will», pp. 84 and 86.
36. *Ibid.*, p. 86.
37. *Ibid.*, p. 88.

Now that philosophy proved itself impotent in reference to causality, one had to turn to the sciences for help. To be sure, the turn was to be mindful of the rights of philosophy, but in the end all basic rights of philosophy were to be handed over to physics. This was implied already in an earlier statement of Planck who conceded causality as being ultimately a philosophical question only on the condition that there should be a collaboration between philosophy and the sciences. The collaboration (as far as causality was concerned) was a mere subjection of philosophy to physics. Or as Planck phrased the *dénouement* of the problem of causality:

> In the case of definite problem which philosophy recognizes as fundamental and the final solution of which is the business of philosophy alone, where philosophy cannot come to a decisive formulation by the use of its own methods, it must seek information from the special branches of science in regard to particular features of the problem at issue. Now if the answer here turned out to be definite and final, then it must be treated as such. It is a characteristic mark of every true science that the general and objective knowledge which it arrives at has a universal validity. Therefore the definite results which it obtains demand an unqualified acknowledgment and must always hold good. The progressive discoveries of science are definite and cannot permanently be ignored[38].

Planck's reasoning, which equated a particular feature of a thing with the thing itself, should not be a cause of surprise in view of his idea of a definite progress displayed by physics. The importance of that idea canot be emphasized enough if one is to have a proper grasp of Planck's epistemology which, as was already said, was ruled by a very specific and rather exalted notion of physical science. This led to an impasse in Planck's epistemology in the same way as was the case with Kant. Planck would have hardly recognized his own predicament had he read Kant's «Enquiry concerning the Clarity of the Principles of Natural Theology and Ethics», written in 1763. There, under the influence of Bishop Warburton's remarks on the atrophying effect on the mind of exclusively geometrical studies, Kant made the very valid and profound statement that nothing harmed philosophy more than its having been cultivated along the lines of geometry, a particular science[39]. Almost in the same breath Kant blinded himself to this insight by suggesting that philospohy

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38. *Ibid.*, p. 90.

39. English translation in Kant: *Selected Pre-Critical Writings and Correspondence with Beck*, translated and introduced by P. G. Lucas (Manchester: University Press 1968), pp. 5-35.

should be patterned after physics. Even if Planck had read the «Enquiry», he did not have to remember it in order to write the foregoing passage, a passage crucial for a proper grasp of his philosophical thinking. It was enough for him to agree with the author of the *Critique of Pure Reason* in which the exactness of Newtonian physics served as pattern for metaphysics in particular and philosophy in general. Since Planck had subscribed to the primacy of physics, in respect at least to some essential philosophical questions, the methodical subjugation by Planck of philosophy to physics could only be a foregone conclusion.

The subjugation was complete for all practical purposes. It was of no consequence to state as Planck did, that physics in investigating causality in physical reality presupposed philosophy to make a start. The start was, in Planck's words, a «jump into the region of metaphysics», and a «leap into the transcendental»[40]. The leap was not a matter of logic but a fiducial act supported by two considerations. One was that science required much more than the data of senses. The latter not only trapped one in solipsism, but also invited that anthropomorphism which science kept transcending as it progressed. The other was that sense data as such were not logical proofs of the existence of the external world. «It is only through the immediate dictate of our consciousness that we know that this world exists», declared Planck[41] who as a Kantian could not perceive that it was natural for man to know external things and that his own consciousness was merely a reflection of his knowing things. Otherwise consciousness was no less a trap serving solipsism as were the data of the senses.

Clearly, whatever priority philosophy (metaphysics) could claim over physics through the indispensability of that act of faith in reality, precisely because the act in question was an act of faith and not a step of plain knowledge, the physicist did not have to remember that priority as he went on cultivating his own specific brand of knowledge. According to Planck, «once the scientist has begun by taking this leap into the transcendental he never discusses the leap itself nor worries about it. If he did, science could not advance rapidly»[42]. One justification of this hardly philosophical policy was the inability to attack it on logical grounds. The act of faith or leap of faith was obviously beyond the confines of mere logic. The act represented a surplus which in Planck's rendering was mystical and not rational. Had Planck not

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40. «Causation and Free Will», pp. 93 and 94.
41. *Ibid.*, p. 94.
42. *Ibid.*

been a Kantian but a philosophical realist, he would have said that knowledge of the real is not a mere conceptualization and therefore more than mere logic. As a Kantian he could not see that while logic dealt with the relative domain of two or several concepts, inert in themselves, knowledge of external reality was a dynamic though natural relationship among the thing, the knower, and his knowledge of it. The other justification was the progress of science, by which Planck meant physics above all. «The history of science is at hand to confirm our faith in this truth»[43], namely, the truth that through science man was progressing toward an ever more genuine grasp of reality. A truth it certainly was but, when claimed by Planck, a mere impasse out of which his Kantianism offered no escape.

Such was a 20th-century replay, through the discourse of a prominent physicist, of the logic of the Kantian dictum that philosophy should be cultivated along the lines of physics. What this ultimately meant was the surrendering to physics as will be seen shortly, even, in respect to the problem of free will. How Kantian was this procedure was spelled out by Planck himself:

> Having once assumed the existence of an independent external world, science concomitantly assumes the principle of causality as a concept entirely independent of sense perception. In applying this principle to the study of natural phenomena science first investigates if and how far the law of causal relation is applicable to the various happenings in the world of nature and in the realm of the human spirit. Science finds itself here exactly on the same footing which Kant took as the starting point of his theory of knowledge[44].

The one exception which Planck took to Kant's legislation on causality was minor and rather elusive if not plainly confused. One wonders what Planck meant in saying that «Kant took not merely the concept causality but also to a certain degree the meaning of the causal law itself as an immediate datum of knowledge and therefore universally valid. Specialized science cannot go thus far»[45]. The distinction between the «concept of causality» and the «meaning of causal law» is best considered as one of those trivial profundities which abound in the writings of any Kantian philosopher, professional or not.

Planck has now reached the second main part of his discourse where he asked with obvious relief: «How far can science help us out of the obscure

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43. *Ibid.*, p. 95.
44. *Ibid.*
45. *Ibid.*

forest wherein philosophy lost its way?»[46] Clearly, he was not at ease with philosophy. His questions about causality (do the sciences take causality for an indispensable postulate and do they insist on its validity in all cases?) did not relate to the nature of causality but merely to the use of it by the sciences. In formulating the answer of physics to these questions Planck admitted that the quantum of action posed certain problems. Indeed he felt that it might impose «essential modifications» of the causality principle as implied in Newtonian physics and its relativistic recasting by Einstein. Now if the modifications were «essential», it was hardly rigorous to state, as Planck did, that nevertheless the «quantum hypothesis will eventually find its exact expression in certain equations which will be a more exact formulation of the law of causality»[47]. Also, if the law of causality as assumed in Newtonian physics was exact, and it certainly was, what kind of reformulation could make it more exact? That in 1923 Planck felt that most physicists shared his hopes about the future of the law of causality may be understandable, but he was a poor prophet nevertheless. That statistical methods introduced in several new branches of physics allowed in principle an exact investigation could, of course, be granted. It was another matter whether on the atomic and molecular level, where statistical methods had their most important role and where the quantum of action was not a negligible quantity, one could reasonably look for at least theoretically exact measurements. At any rate, Planck took the idea of exact measurement as equivalent to strict causality.

Planck then turned to biology where he registered an ever wider admission of exact chemical interactions. He would have done far more justice to biology had he referred to the unabated struggle of biologists with the notion of teleology. The statement, by then half a century old, of a German biologist that teleology was for any biologist an indispensable companion though not one to appear with in public[48], could hardly be unknown to Planck. But Planck's mind was too firmly set in the groove of that identification of the measurably exact with the causal and the real to make room for other aspects of the problem. This is well illustrated by his sudden broaching, at the end of his reflections on biology, of the question whether causality was after all a mere hypothesis. Planck's answer was that causality was a very special hypothesis which accounted for the finding of any «definite rule» in any field of science[49]. The

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46. *Ibid.*, p. 96.

47. *Ibid.*, p. 98.

48. The remark is usually credited to von Bruecke. See W. I. B. Beveridge, *The Art of Scientific Investigation* (rev. ed.; New York: Random House, n.d.), p. 83.

49. «Causation and Free Will», p. 104.

«definite» obviously meant quantitatively exact and also verifiable as such.

This identification by Planck of exact, or rather of the exactly measurable, with causal, was very much in view as he discussed the answer of the humanities (psychology and sociology in particular) to the question of the status of causality. As was already noted, he was strongly inclined to take cogitation, however creative, for a predetermined process. Modern psychological research gave, in his view, heavy support to the subjection of mental processes to the law of causality:

> The principle of causality must be held to extend even to the highest achievements of the human soul. We must admit that the mind of each one of our greatest geniuses —Aristotle, Kant or Leonardo, Goethe or Beethoven, Dante or Shakespeare— even at the moment of its highest flights of thought or in the most profound inner workings of the soul, was subject to the causal fiat and was an instrument in the hands of an almighty law which governs the world[50].

Typically, the difficulty of seeing an unbroken chain in all mental processes was answered by Planck with a reference to a purely physical analogy. If this was already revealing, even more so was Planck's interpretation of the analogy, the uncertain outcome of throwing an asymmetrical dice. The uncertainty lay, of course, in our inability, owing to our incomplete knowledge of all quantitative parameters of such throw, to say nothing of its dynamics, to predict the outcome. Planck described that inability as an inability «to detect the function of strict causality»[51]. Planck's dismissal of «absolute chance» might have led him to causality as an ontological question had he not seen in causality above all a mental category. Only on occasion did he attribute to it the status of being transcendental to and independent of the perceiving mind. Even in such cases he quickly fell back on to the shallows of exact measurability and observation. Actually, he fell back there not only quickly but almost readily. Once on those shallows, he felt he could answer the objection that free will was therefore a mere phantom. Free will, the ethical responsibility of man, and the inviolability of his ego (person), could be defended, so Planck insisted, because a complete observation (measurement) of one's own acts was a *practical* impossibility, whatever the *theoretical* possibility of a full observation and therefore the rigorous ascertaining of causality. Our freedom was therefore not an ontological principle but a pragmatic precept resting on a mere ina-

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50. *Ibid.*, pp. 109-10.
51. *Ibid.*, p. 108.

bility on our part to analyse with full objectivity our actions and chains of motivation. To a superior spirit, such as the one described by Laplace, all our so-called free actions could be seen as fully determined. The Laplacian spirit too, although a mystery to himself because his ego could not become his own object, was an open book to a Supreme Wisdom (if there be one, Planck added)[52], whose celestial nature is infinitely elevated above us.

Whether that Supreme Wisdom was free only because as his own subject he could not fully become his own object of observation, Planck did not discuss. Had he done so he might perhaps have caught a glimpse of the manner in which one's notion of the ultimate in being and intelligibility conditioned all of one's philosophical utterances, provided they were consistent. In Planck's case that notion was heavy on the side of «idea» and very light on the side of «being» or reality. Planck's philosophical means of securing reality were markedly idealistic such as the «metaphysical leap» and the categories which barred him from *knowing* reality. For the idealist he was, it was not possible to state that man *knew* reality and that causality was a matter of knowing the real and not a mere matter of categories, let alone of scientific techniques. Idealist philosophy could not encourage him to recognize that his own ability to move his little finger at will contained much more realist evidence both about himself and the world than all the laws of all the sciences. Thus he was helplessly pushed by his favorite theme, measurably deterministic causality, to the extreme where it engulfed man's mind and will. No wonder. Idealism was a vote cast on behalf of a priori categories and «truths» which held the human mind prisoner of its own presumed structure. Within such a framework reality could only be brought back through the schizophrenic device of a fiducial leap in the dark, hardly a step of rationality, and the free will could be salvaged only through the even more schizophrenic precept of a categorical imperative.

The lecture of 1923 provides by far the most systematic exposition by Planck of his reflections on epistemological topics. His two other lectures on causality, delivered in 1926 and in 1932, were mere rephrasing and regrouping of themes developed in the 1923 lecture[53]. They equally show him a prisoner of his cherished themes, mechanistic causality and the Kantian precepts of epistemology. As a system, Planck's epistemology offers nothing original;

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52. *Ibid.*, p. 117.

53. The former, «Physikalische Gesetzlichkeit» (*Vorträge und Erinnerungen,* pp. 183-205) has not yet been translated into English. The other, «Kausalität in der Natur», appeared in English under the title, «Causation in Nature»; see *The New Science,* pp. 259-90.

it is not even profound, unless profundity is taken for brave consistency. It is even short on pregnant phrases which make the reading of Einstein's much shorter philosophical essays a more refreshing experience. Yet Planck's epistemology, especially as portrayed in that 1923 lecture, is worth studying. A survey of half truths, plain errors, blind alleys, hapless impasses is not without its instructiveness especially when they are tied to the name of a great physicist. The pre-eminent position, almost pontifical role, with which leading physicists, especially when decorated with a Nobel Prize, are accredited in our culture is not something to be taken lightly. It makes a very sad reflection on that scientific culture of ours that the inability of scientific expertise to guarantee philosophical expertise comes largely as startling news. And so does any reference to science as a major source of the sprouting up of ever new philosophical systems. The novelty is only apparent. The major philosophical options of our times reflect, though in ever more virulent and accelerated way, that process of being tossed to and fro in which philosophy finds itself since the rise of science. With ever increasing frequency, philosophy is swinging from an aping of scientific exactness to a reveling in the irrational. The story, often told, need not be reviewed here. Perhaps the story would have more constructive strength if more attention were paid there to the philosophizing of leading modern physicists. This is not to suggest that most of the time one could find much texture in that philosophizing, which almost invariably brings out the truth of Einstein's poignant remark: «The man of science is a poor philosopher»[54].

Such an admission has more mental health to it than the sophisticatedly articulated claims of certain philosophers who largely succeeded in being taken for the authoritative interpreters of modern science. The fumbling of prominent physicists in matters philosophical will not escape a reader with a modest measure of critical sense. Quite different is the case with lengthy treatises, mostly devoted to logical refinements, although even there the same reader should be taken aback by the end results. There reality subtly vanishes, the universe dissolves into a haphazard succession of particles, so many creations of the scientific mind, while that very mind is turned into the inert locus of concepts, none of which is more related to reality than the other. Like the scene of organic evolution and social development, where everything is said to be ruled by a grim struggle for survival and endless revolutions, the domain of science too becomes a mere series of successes which, being purely

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54. «Physics and Reality» (1936), in: *Out of my Later Years* (New York: Philosophical Library 1950), p. 58.

relative, cannot in the end be taken for a progress and certainly not for that progress which Planck held high.

Against that background Planck's philosophical reflections on science may be a much-needed antidote, whatever the mistaken philosophical framework within which he tried to make his main points. The spirited affirmations by Planck of a fully ordered external world were not inspired by his idealist philosophy but by his deep scientific engagement for a more comprehensive view of physical reality. That reality was for him absolutely given, that is, in no way the creation of the mind, scientific or other. This is why he saw well before Einstein, the absolutist and objectivist character of relativity theory[55]. What he failed to see was that impasse into which he unnecessarily led himself by trying to justify with the shibboleths of Kantian tradition the esteem of a fully coherent objective physical reality which science inspired in him. Far from being necessary, the impasse rested on the transparent fallacy of equating that which cannot be «ascertained» exactly with that which is not fully «determined» or really caused.

Quantum mechanics was not yet half a dozen years old when that fallacy was pointed out in a prominent scientific journal[56], though in vain if the continued popularity of the Copenhagen interpretation of quantum mechanics means anything. In an age of logical positivism, a logical distinction, strong enough to lay bare that fallacy, would not generate an escape from the impasse it produced. A philosophical appreciation of the real, which Kantianism and its varied offshots could not provide, was no less required. Blinded by Kantianism, Planck readily took classical mechanics as an assurance that real interaction among real things was not more than the predictability of its mathematical exactness.

This is the reason why Planck, who was ready to follow up steps leading to a major revolution in physics, remained a «reluctant revolutionary»[57]. To be sure, he never spoke of revolutions in science in the self-defeating sense implied in the succession of incommensurable patterns, with the «incommensurable» being taken for ontological incoherence. If the progress of science

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55. Planck did so in 1924 in his lecture «From the Relative to the Absolute», *The New Science,* pp. 123-54.

56. Letter to the Editor, *Nature* Dec. 27, 1930, p. 995. Of course, as the letter was written by E. J. Turner, a now completely-forgotten teacher at the University of Liverpool, his most justified remarks could not make as much as a dent on a rapidly forming consensus.

57. Indeed, the «most reluctant revolutionary of all times», to recall a felicitous phrase of L. Pierce Williams in his «Normal Science, Scientific Revolutions, and the History of of Science», in: *Criticism and the Growrh of Knowledge,* ed. I. Lakatos and A. Musgrave (Cambridge University Press 1974), p. 50.

needed a revolutionary or drastic step, Planck did not recoil from pioneering it. In fact, as he himself recalled, he worked frantically during the closing months of 1900 for snatching victory in a race for the theoretical derivation of the shape of the black-body radiation curve already established on experimental grounds. It was no secret to him that this feat of his would match in significance that of Newton. Years later, when Einstein extended the quantum of mission into a quantum of propagation, Planck, as Einstein recalled, considered the arguments with complete disregard for his own preferences[58]. The true source of his dislike of discontinuity, be it of emission or of propagation or of both, was not so much scientific as philosophical. Unfortunately, those reasons remained muddled as he kept articulating them. In trying to reverse the stampede of those whom he called «indeterminists» he put emphasis not so much on causality as on a special aspect of it, and much less on reality without which causality makes no sense.

Planck must not, however, be judged too harshly. After all, his erst-while protégé, Einstein, came to perceive in full only in his last years, after growing tired of a long debate with Born, that the real bone of contention between them concerned the status of reality[59]. But there is little to defend in Planck's defense of reality through his advocacy of metaphysical leaps and acts of faith. Such leaps and acts remain pieces of idealist rhetoric when not supported by a philosophy which transcends mere empiricism, and even a so-called «rationalist» metaphysics. Thus Planck's arguments failed to impress the leader and the chief representatives of the Copenhagen school who, if they had any philosophy, gloried in some variation of pragmatism. Nothing was easier for them than to turn the tables on Planck who loved to refer to the fruitfulness of causal thinking in physics[60]. In quantum mechanics, where all basic operations are statistical, probability proved itself useful beyond the most sanguine expectations. It was another matter to use that usefulness as a cover-up for casting doubt on the coherence of the universe at its fundamental level, nay, at existence itself. The gist of that procedure was a systematic refusal to consider questions of ontology[61]. Indeed, in that procedure

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58. Einstein's words are quoted in A. Hermann, *Max Planck in Selbstzeugnissen und Bilddokumenten* (Reinbek bey Hamburg: Rowohlt 1973), p. 45.

59. See *The Born-Einstein Letters: Correspondence between Albert Einstein and Max and Hedwig Born* (New York: Walker and Company 1971), pp. 216-24.

60. Already in his first major non-technical address, delivered in Leiden in 1908, «On the Unity of the Physical Universe», a frontal attack on the sensationism advocated by Ernst Mach.

61. Such is the conclusion of the most comprehensive study on Bohr's epistemology, «The Nature of Quantum Mechanical Reality: Einstein versus Bohr», by C. A. Hooker,

accidental or chance events stood opposed not to determinate events, but simply to reality itself[62].

While Planck failed to see this, he sensed something of his opponents' systematic way of sapping, in the manner of parasites, the tree of reality, which pre-20th-century scientific thinking still duly revered and which, of course, cannot be exorcised or cut down by any science, however successful. Parasites, it is well to recall, have always formed very successful species. To argue effectively against their kind, parading as scientific philosophers, the cause of reality demanded much more than the sincere zeal for the real which animated Planck, the scientist. The same cause could be only compromised by failing back on the 'Ding an sich' which, with most other results of Kant's philosophy, Planck accepted. Being merely the spurious product of a second or third step in reasoning, the «thing in itself» deprived reality from being the very starting point of that episteme which alone can issue in consistent human understanding.

ΑΔΙΕΞΟΔΟ ΤΗΣ ΓΝΩΣΙΟΘΕΩΡΙΑΣ ΤΟΥ PLANCK

Π ε ρ ί λ η ψ η

Ἡ θεωρητικὴ φυσικὴ τράβηξε ἐξαρχῆς τὴν προσοχὴ τοῦ Planck ὡς ἕνα πεδίο ποὺ ἐπηρεάζει ἀποφασιστικὰ τὴ γνωσιοθεωρία. Ἔτσι, ὅταν βρῆκε στὴν ἀθροιστικὴ μέθοδο, ὡς διαφορετικὴ ἀπὸ τὸν ἀπειροστικὸ λογισμό, τὸ κλειδὶ γιὰ τὴν ἀκτινοβολία τοῦ μελανοῦ σώματος, ἔβγαλε ἀμέσως τὸ συμπέρασμα ὅτι ἡ συνέχεια τῶν αἰτιακῶν σχέσεων μπορεῖ νὰ ἀναιρεθεῖ. Ἀπρόθυμος νὰ ἐγκαταλείψει τὴν ἀπόλυτη αἰτιότητα, στὴν ὁποία ἔβλεπε τὴ μόνη ἐγγύηση γιὰ τὴ (γνωστική) σύλληψη τῆς πραγματικότητας ἐκ μέρους τοῦ ἀνθρώπου, προσπάθησε, μισὸ σχεδὸν αἰώνα, νὰ βγεῖ ἀπὸ τὸ ἀκόλουθο ἀδιέξοδο: ἀφενὸς ὑποστήριζε τὴν ἀπόλυτη ἐγκυρότητα τῆς

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in R. G. Colodny (ed.), *Paradigms and Paradoxes: The Philosophical Challenge of the Quantum Domain* (Pittsburgh: University of Pittsburgh Press 1972), pp. 67-302. See especially p. 208.

62. As argued and documented in my «Chance or Reality: Interaction in Nature versus Measurement in Physics», *Philosophia* 10-11 (Athens 1980-81), pp. 87-105, reprinted in my book, *Chance or Reality and Other Essays* (Lanham, Md.: The University of Press America 1986).

ἀκριβοῦς μέτρησης κάθε ἀλληλεπίδρασης (μέτρηση), τὴν ὁποία θεωροῦσε ὡς τὴ μόνη ἀπόδειξη τῆς αὐστηρῆς αἰτιότητας καὶ ἄρα τῆς πραγματικότητας τῆς ἀλληλεπίδρασης: ἀφετέρου ἀποδεχόταν τὴν ἐγκυρότητα τῆς στατιστικῆς ἢ ἀσυνεχοῦς φύσης τῶν κβαντομηχανικῶν διαδικασιῶν, γιὰ τὴ θεμελίωση τῶν ὁποίων πολὺ βοήθησε ἡ ἀνακάλυψή του τοῦ κβάντου δράσης.

Ὁ Planck ἀναζήτησε μιὰ διέξοδο (αὐτοῦ τοῦ ἀδιεξόδου) καταφεύγοντας στὸ ἀνώτερο πνεῦμα τοῦ Laplace, πού, κατέχοντας μιὰ ἀκριβὴ γνώση ὅλων τῶν παραμέτρων, μπορεῖ νὰ προείπει μὲ πλήρη μέτρηση ὅλα τὰ μελλοντικὰ γεγονότα. Ἦταν μ' αὐτὴ τὴν ἔννοια ποὺ ὁ Planck προσπάθησε νὰ ἄρει τὴ σύγκρουση μεταξὺ ἐλεύθερης βούλησης καὶ φυσικῆς αἰτιοκρατίας, εἰδικὰ στὸ δοκίμιό του *Νόμος τῆς αἰτιότητας καὶ ἐλευθερία τῆς βούλησης* (1923), στὸ ὁποῖο καὶ παρέχει τὴν πιὸ συστηματικὴ ἔκθεση τῆς γνωσιοθεωρίας του.

Ἡ πάλη τοῦ Planck μὲ τὸ πρόβλημα τῆς αἰτιότητας πρόλαβε τὶς (ἀξιωματικές) προκείμενες τῆς ἑρμηνείας τῆς Σχολῆς τῆς Κοπεγχάγης (γιὰ τὴν κβαντομηχανική), οἱ κύριοι ἐκπρόσωποι τῆς ὁποίας ἁπλῶς θεώρησαν ὡς στερούμενο νοήματος τὸ πρόβλημα τῆς αἰτιότητας καὶ τῆς πραγματικότητας, προβλήματα ποὺ κατεῖχαν τὴν πρώτη θέση στὴ σκέψη τοῦ Planck. Ὁ Planck μπορεῖ νὰ εἶχε βρεῖ ἕνα ἱκανοποιητικὸ τρόπο νὰ ξεφύγει ἀπὸ τὸ γνωσιοθεωρητικό του ἀδιέξοδο, ἂν ὁ νεοκαντιανὸς ἰδεαλισμός του δὲν τὸν εἶχε ἐμποδίσει νὰ ἐκτιμήσει τὸν ρεαλισμὸ τῶν μεγάλων Σχολαστικῶν φιλοσόφων, γιὰ τοὺς ὁποίους ἡ ἀναγνώριση τῆς ἀντικειμενικῆς πραγματικότητας ἦταν ἡ προϋπόθεση κάθε συζήτησης γιὰ τὴ φυσικὴ αἰτιότητα. Ἂν ὁ Planck τὸ εἶχε ἀντιληφθεῖ αὐτὸ θὰ εἶχε ἴσως θεμελιώσει καλύτερα τὴν ἀντίθεσή του στὴν ἑρμηνεία τῆς σχολῆς τῆς Κοπεγχάγης (γιὰ τὴν κβαντομηχανική), σύμφωνα μὲ τὴν ὁποία ἀναγνωρίζονται ὄψεις μόνο τῆς πραγματικότητας ἀλλὰ ὄχι ἡ πραγματικότητα ἡ ἴδια.

Τὸ γνωσιοθεωρητικὸ ἀδιέξοδο, ἀπ' τὸ ὁποῖο ὁ Planck δὲν μποροῦσε νὰ ξεφύγει (ἐπειδὴ ἦταν) συνεπαρμένος ἀπὸ τὴν ἀκριβὴ μέτρηση —μιὰ ἀλληλεπίδραση ποὺ δὲν μπορεῖ νὰ μετρηθεῖ μὲ ἀκρίβεια, δὲν μπορεῖ καὶ νὰ λάβει χώρα μὲ ἀκρίβεια— τὸ ὁποῖο βρίσκεται στὴ βάση τῆς ἑρμηνείς τῆς κβαντομηχανικῆς ἀπὸ τὴ σχολὴ τῆς Κοπεγχάγης.

USA S. L. Jaki

(Μετάφραση Γ. Ἀλατζόγλου-Θέμελη)