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DISCUSSION ARTICLE I:

The Physicist and the Metaphysician

by Stanley L. Jaki

The attitudes of physicists toward metaphysics covers a wide range which rarely includes genuine appreciation. In our century Max Born referred to the "dry tracts of metaphysics" after having set forth the stunning ability of modern atomic physics to deal with material reality.¹ Appreciation for the metaphysician's message was not much in view when Einstein invoked the physicist's right to have his own definition of time.² He did so after Bergson confronted him with the question whether the reality of time did not call for much more than the perspectives of physics, relativistic or not. Still earlier the usually restrained Maxwell portrayed metaphysics as a den of thieves full of dry bones.³

Of course the metaphysician whom Maxwell had in mind was a devotee of German idealism. Its two main forms, Kantianism and Hegelianism, could provide only a straitjacket for the physicist. Helmholtz spoke of the near trivialities to which certain claims of Kant about physical laws came.⁴ Considerably earlier, metaphysical speculation had much attraction for physicists. It should be enough to recall Newton's infatuation with the Cambridge Neoplatonists as shown by his quasi-mystical discourse

¹ M. Born, *Atomic Physics*, tr. J. Dougall (London, 1957), p. 312.

² See the transcript of Einstein's replies to questions posed to him by leading French philosophers at the Sorbonne on April 5, 1922 in *Bulletin de la Société Française de Philosophie* 17 (1922), pp. 101-102.

³ J. C. Maxwell, "Address to the Mathematical and Physical Section of the British Association" (1870) in *Scientific Papers of James Clerk Maxwell*, ed. W. D. Niven (Cambridge, 1890), vol. II, p. 216.

⁴ H. von Helmholtz, "On the Origin and Significance of Geometrical Axioms" (1870), in *Popular Scientific Lectures*, ed. M. Kline (New York, 1962), p. 239. For other statements of prominent physicists on the merits of metaphysics, see my *The Relevance of Physics* (Chicago, 1966), pp. 330-35.

about infinite space as the sensorium of God. Newton's erstwhile enthusiasm for Cartesian metaphysics turned in the end into an embarrassment. In his older days Newton spent many hours in striking out references to Descartes from his manuscripts. The havoc played by Cartesian metaphysics in Cartesian physics was the gist of Huygens' remark that Descartes' account of the workings of the physical world amounts to a mere novel.⁵

While physicists could be justified in their contempt for idealistic and Cartesian metaphysics and should have been wary of some other types as well, they were never free of some debt to metaphysics. Apart from such general notions as that of a fully ordered universe and real causality, metaphysics first proposed such particular notions as atomicity and mutual attraction of bodies. Furthermore, metaphysics is invoked, knowingly or unknowingly, by the physicist when he feels the need for some clarification in his own field. A philosopher however first protested against the steady-state cosmologists who claimed that a certain radiation could, if experimentally detected, prove the emergence of hydrogen atoms out of nothing.⁶ Today, when many cosmologists blithely conjure up the emergence of entire universes out of nothing with the help of mere mathematical formulas, only a realist metaphysics provides a way out of Platonist misconceptions about the relation of abstract ideas to real matter.

Popularity of the inflationary universe, the target of the preceding remark, is but the latest symptom of a chronic insensitivity of physicists to elementary questions of metaphysics. Underlying that symptom is the blind surrender of most 20th-century physicists to the elementary philosophical fallacy which forms the basis of the Copenhagen interpretation of quantum mechanics. The fallacy is the inference that an interaction that cannot be measured exactly cannot take place exactly. The inference, in which the same word *exactly* is taken in an operational sense and then in an ontological one, reveals a shocking insensitivity to basics in metaphysics. For the past half century the fallacy has been

⁵ Manuscript # 2791 in *Oeuvres complètes de Christiaan Huygens* (The Hague, 1888-1950), vol. 10, p. 403.

⁶ The philosopher in question was M. K. Munitz. See his article, "Creation and the 'New' Cosmology," in *British Journal for the Philosophy of Science* 5 (1954-55), pp. 32-46.

repeatedly pointed out but to no avail.⁷ The overwhelming majority of physicists is just as insensitive today to questions of metaphysics as in the days immediately after Newton when Berkeley noted in vain the philosophical cracks running through the proud edifice of mechanistic physics. Unfortunately, the solipsism he offered for remedy made the cracks appear preferable.

The most notable and praiseworthy exception to that overwhelming and often overweening majority remains Pierre Duhem who excelled not only as a physicist but also as a philosopher and historian of science.⁸ He had not published anything as a physicist for ten years when his long essay "Physique et métaphysique" appeared.⁹ Principal aspects of that essay found their way into his far more widely read masterpiece, *La Théorie physique (The Aim and Structure of Physical Theory)*.¹⁰ A hitherto undiscovered aspect of Duhem's sensitivity to the respective treatments which physics and metaphysics give to the same question is found in his correspondence (consisting of nine exchanges of letters) with the French Dominican metaphysician and theologian, Reginald Garrigou-Lagrange between January 7, 1909 and June 10, 1914.¹¹

Duhem's presence in the department of physics at the University of Bordeaux could hardly remain unknown to young Garrigou-Lagrange¹² who studied medicine there from the Fall of 1895

⁷ See ch. 1 in my *Chance or Reality and Other Essays* (Lanham Md., 1986).

⁸ For a discussion see ch. 9 and 10 in my *Uneasy Genius: The Life and Work of Pierre Duhem* (Dordrecht, 1984), paperback edition, 1986.

⁹ Published originally in 1893. Reprinted with five other articles of Duhem with my introduction under the title, *Prémices philosophiques* (Leiden, 1987).

¹⁰ The first edition (1906) was followed by a second, enlarged one by Duhem himself in 1914, reprinted in 1934 and in 1981. The English translation by P. P. Wiener (1954) was reissued ten years later as an Athenium paperback.

¹¹ Their correspondence, only conserved in part, consists of nine letters from Garrigou-Lagrange to Duhem (since 1981 in the Archives of the Académie des Sciences in Paris and available to researchers) and of letters (whose number was not communicated to me) by Duhem to Garrigou-Lagrange, in the archives of Angelicum, the Pontifical University of the Dominicans in Rome. See fn. 33 below.

¹² On the life and work of P. Garrigou-Lagrange, see *Angelicum* 42 1/2 (1965).

until he entered the Dominican order in the summer of 1897. Duhem's arrival in Bordeaux in the fall of 1894 was widely hailed there as a signal addition to the prestige of the University. Attendance at an introductory course in physics, obligatory for beginning medical students, would have been enough to hear of Duhem who attracted to Bordeaux some of his best former students in Lille and whose growing list of publications in the *Annuaire* of the University of Bordeaux became a legend there and a cause for the envy of not a few.

At any rate, no sooner had young Garrigou-Lagrange joined the French Dominicans at Le Saulchoir, near Tournai in Belgium in 1897 (their expulsion by the lividly anticlerical Third Republic became complete by 1904) than he encountered Duhem's name with increasing frequency as his philosophical training went on. Belgium was the center of an Association of Catholic scientists with a heavy French membership (one fourth of the Académie des Sciences in Paris were members in 1900) and with a broadly read quarterly, *Revue des questions scientifiques*. Founded in 1877 by the Belgian Jesuit, I. Carbonelle, the *Revue* represented that part of the Neo-Thomist movement where questions about science and philosophy were most in focus. The Association had several members in the Faculté des Sciences of the University of Lille. They may have been the ones who forged the first link between Duhem and the *Revue*, about which Duhem, keen on matters Catholic, must have known from his upperclassman years at the Collège Stanislas. A chief glory of the Association was Hermite who was wont to visit one of his favorite students, the Abbé Biehler, a mathematician in his own right and director of studies at the College. The Abbe Biehler introduced young Pierre to the elderly Hermite on one such occasion.

The five long essays and a book review which Duhem published between early 1892 and mid-1894 in the *Revue* marked him for special attention when in September 1894 he attended in Bruxelles the Third International Scientific Congress of Catholics organized by the Association. Several Dominicans from Le Saulchoir were present, including Garrigou-Lagrange. Like many others, they must have been struck by Duhem's warning against Catholic philosophers and theologians who discuss science without

having studied it systematically and over many years.¹³ Garrigou-Lagrange may have established contact with Duhem then, although at the time he could not know that Duhem was soon to move from Rennes (where he taught 1893-94) to Bordeaux, a city on the road from Belgium to Auch, the birthplace of Garrigou-Lagrange and the home of his parents. Duhem learned only on October 13 that he had just been transferred from the University of Bordeaux. News of this may have eventually been conveyed by Duhem himself to the young Dominican priest who was invited to make a stopover in Bordeaux during his next visit to Auch. Garrigou-Lagrange's third extant letter to Duhem written October 15, 1909 contains a fond reference to a long conversation which he had with Duhem "in the great park of Bordeaux five years earlier," very likely in the spring or early summer of 1904.

That letter of October 15, 1909, contains other valuable information as well. Duhem was given the news that Garrigou-Lagrange was to move shortly to Rome as professor of fundamental theology at the Angelicum, the newly organized Dominican Pontifical Institute of theology in Rome. Garrigou-Lagrange extended an invitation to Duhem to visit him in a city where "so many foreigners come anyhow." Garrigou-Lagrange also thanked Duhem for four reprints. One contained Duhem's edition of a previously unknown part of Roger Bacon's *Opus tertium*. Among the three others, Garrigou-Lagrange mentioned that on Thierry de Chartres and Nicholas of Cusa.¹⁴ In return, Garrigou-Lagrange promised to send Duhem a reprint of an article of 110 large-octavo columns which he was publishing on "Dieu" in the *Dictionnaire Apologétique de la Foi Catholique*.¹⁵ Last but not least he thanked Duhem for his very long letter.

Duhem's long letter was a reply to a long letter which Garrigou-Lagrange wrote to Duhem on July 10, 1909. Half a year earlier,

¹³ For details, see *Compte rendu du Troisième Congrès Scientifique International des Catholiques tenu à Bruxelles du 3 au 8 septembre 1894* (Bruxelles: Société Belge de Librairie, 1895), Septième Section—Sciences mathématiques et naturelles, pp. 323-24, and my *Uneasy Genius*, pp. 112-13.

¹⁴ In the full bibliography of Duhem's publications (*Uneasy Genius*, pp. 437-55) see 1909:1 and 1909:8.

¹⁵ My references are to the 4th edition (Paris, 1925), *Tome Premier. Agnosticisme—Fin du Monde*, cols. 941-1088.

on January 7, Garrigou-Lagrange thanked Duhem for sending him an inscribed copy of his book *SOZEIN TA PHAINOMENA, Essai sur la notion de la théorie physique de Platon à Galilée*.¹⁶ This suggests that there had been exchanges of letters between Garrigou-Lagrange and Duhem during the previous four years. At any rate, in that letter of January 7th (the first of the nine extant letters written by Garrigou-Lagrange to Duhem) Garrigou-Lagrange explicitly deals with his deep interest in the argument for the existence of God taken from the reality of motion. This topic is also the principal subject of the five more letters sent by Garrigou-Lagrange to Duhem.

I take the liberty—wrote Garrigou-Lagrange to Duhem on January 7—of sending you in a few weeks a formulation of the proof from motion for the existence of God. You would greatly oblige me if you kindly told me whatever in that proof does not seem to you convincing.

Why did the philosopher-theologian feel the need to have his reasoning evaluated by the physicist? The answer is spelled out in Garrigou-Lagrange's next letter (July 10, 1909) which begins with a grateful acknowledgement of a copy of Duhem's latest publication: *Le mouvement absolu et le mouvement relatif*. There Garrigou-Lagrange found a passage¹⁷ which contained in a nutshell the problem he, as a metaphysician, concerned with that classic proof from motion, faced with respect to physics. In that passage Duhem stated that "according to the principle of inertia a body of infinitely small dimensions and existing alone in a three-dimensional co-ordinate system, would move with respect to that system with a constant velocity along a straight line." This statement Garrigou-Lagrange rightly took as equivalent to the formula: "a body which is not subject to any force can only have a rectilinear movement." Then he summed up Duhem's view on the principle of inertia as a notion

¹⁶ Reprinted in 1982 (Paris). An English translation, with my introduction, was published by the University of Chicago Press, 1969, reprinted in 1985.

¹⁷ The work was a collection of twelve articles published in *Revue de philosophie*, 1907-09. For the passage quoted by Garrigou-Lagrange, see p. 274 in 1909:11 in the bibliography quoted in fn. 14 above.

which is neither a truth imposing itself *a priori* (capable of being derived from the principle of sufficient reason), nor a truth demonstrated experimentally, as Newton believed, but a postulate suggested by certain facts (such as, for instance, the motion of projectiles that continues when the impulse has ceased) and extended subsequently to more general cases, although the extension can neither be confirmed nor contradicted by experiment.

Garrigou-Lagrange would readily grant that the principle of inertia could not be deduced from the principle of sufficient reason. But he also suspected that the principle of inertia contradicted both the principle of sufficient reason and the principle of causality. His reason for this derived from the Aristotelo-Thomistic understanding of motion. Not only did a body need a cause if it was to pass from rest to motion but its motion would also cease once the cause of its motion ceased to act. In such a perspective motion was not a mere state or a reality that remained the same as it passed from one body to another, but a becoming (*devenir*), a passage from potency to act. In such a perspective the mover had to act continuously on the moved as it occupied ever new positions in its rectilinear motion. The proof of this perspective was, according to Garrigou-Lagrange that its abandonment implied the abandonment of the principle of identity and contradiction:

In fact, to say that change of position is a successive union of diverse elements (of position A and position B) or that the unconditional union of diverse elements is possible, is to say that elements by themselves diverse can of themselves (unconditionally) be really one (at least by a unity of union) which is the denial of the principle of identity, and consequently of the principle of non-contradiction.

According to Garrigou-Lagrange this abandonment of the principle of contradiction and identity was the basis of the claim of Hegel and all pantheists, and of evolutionists such as Bergson, that "becoming is its own reason," in which case reality becomes a "realized contradiction." The very opposite was true in classical or Aristotelo-Thomist metaphysics:

the principle of identity and of non-contradiction is not only a law of abstract thought but a basic law of reality, therefore the becoming cannot be its own reason, but must have in the final account

its reason in that reality which is identical with itself, absolutely simple and unmovable, and is, with respect to being, as A is to A, *ipsum esse subsistens*, and consequently essentially distinct from a multiple and changing world.

One had to be on guard against attributing to the law of inertia an absolute scientific truth therefore, since it implied a metaphysical absurdity. It was to avoid that absurdity, Garrigou-Lagrange added, that Aristotle invented his own scientific theory of motion and the late scholastics invented the theory of impetus.

What then was the exact scientific meaning of the principle of inertia? Did it bear only on the modality of motion (rectilinearity and constant velocity) or did it imply that a thing moved without being subject to an extraneous agent or force? If the principle bore only on the *modality* of motion, science remained within its domain. If the principle bore on the *reality* of motion, science not only overstepped its domain but also could come in conflict with the great laws of metaphysics: causality, sufficient reason, and identity (non-contradiction).

But, Garrigou-Lagrange asked, if the principle of inertia contradicted the fundamental laws of reason how could it become the basis of modern physics? He recalled his consultation with Professor Boulanger,¹⁸ of the Faculté des Sciences of the University of Lille, who often visited Le Saulchoir and who recommended Painlevé's essay on the principles of mechanics to Garrigou-Lagrange.¹⁹ Boulanger did so with the remark that Garrigou-Lagrange would find in it essentially the same conflict registered between scholastic mechanics and Copernican mechanics.²⁰ The es-

¹⁸ That is, Auguste Henry Leon Boulanger (1866-1923), maitre de conférences at that time and subsequently professor of mechanics.

¹⁹ This essay, "Mécanique," by Paul Painlevé (1863-1933) in *De la méthode dans les sciences* (Paris, 1909), pp. 363-409, appeared just before his entering politics. For the surprising absence of Duhem from among the twelve contributors, see my *Uneasy Genius*, p. 354.

²⁰ Painlevé certainly registered opposition between the two mechanics, but his reconstruction of the reasons for the direction taken by the "Copernicans" remains a classic example of the superficiality with which first rate physicists reconstruct the history of science without having studied it. Consultation with his old friend, Duhem, would have prevented Painlevé from submitting phrases, hardly different from fiction: "We can throw a stone in a given direction with greater or smaller velocity

sence of that conflict was that for the scholastics there could be no acquired velocity (*vitesse acquise*) and this was enough "to create an abyss between the two doctrines." To this Garrigou-Lagrange added: "I cannot see how the principle of inertia taken in the Copernican sense is not a violation of a basic principle of reason."

To avoid that contradiction an essential difference should be made between rest and motion. The former is a state but the latter is not. This is why one must not say that a small finite impulse can produce an infinite effect. Yet this is what the Copernicans say. Garrigou-Lagrange added in a note that he saw the same problem treated in Emile Meyerson's recent *Identité et Réalité*²¹ and remarked that Mr. Boulanger found much to be desired in that book from the scientific viewpoint. Garrigou-Lagrange's excuse for his lengthy analysis of the principle of inertia had to do with the fact that he was uneasy with that principle as he was writing his long article "Dieu" for the *Dictionnaire Apologetique de la Foi Catholique*. There, as was already noted, a central part of his defense of the rational proof of the existence of God depended on the metaphysical content of the reality of motion as set forth by Aristotle and Thomas.²² The proof implied a series of causes that acted or produced motion in a broad sense simultaneously and subordinate to one another. A man's decision to use his arm to move a hammer was one such example. It showed the simultaneous action of a spiritual, a biological, and a purely physical entity, subordinate to one another in a hierarchi-

. . . But the subsequent motion of the stone is determined from that very moment. Starting from that every-day observation, the Copernicans admitted that the initial conditions of a material system are the positions and velocities of its atoms" (pp. 385-86). This was certainly not the reasoning of Copernicus and the Copernicans of the 17th century. The first glimpses of the historical truth about the discovery of the notion of inertial motion had already been given by Duhem.

²¹ See fn. 47 below.

²² The metaphysical content of this principle was very different from its physical content even in the perspective of Thomas Aquinas. Inattention to this fact has been the cause of the misinterpretation of that principle in many studies on the history of the notion of inertial motion, as shown in J. A. Weisheipl's magisterial study, "The Principle *Omne quod movetur ab alio movetur* in Medieval Physics," *Isis* 56 (1965), pp. 26-45.

cal sense. In the purely physical world the same appeared to be the case in the respective dependence of a sail on a ship, of a ship on the current, of the current on the earth, of the earth on the sun, etc. Simultaneity, but without hierarchical subordination. The *same* gravitational attraction was at play in each link of the chain of that cause-effect relationship. Worse, and this aspect of the problem was not noted by Garrigou-Lagrange, the chain of causes in question could just as well be read in the reverse sense, in virtue of Newton's second law according to which action equals reaction.

Garrigou-Lagrange's question, "Cannot one have, without going beyond the physical realm, an example of a [hierarchically] ascending series that would allow the visualization of the proof?" was a call to Duhem, the physicist, for help. Garrigou-Lagrange felt confident that by writing an article on the principle of inertia Duhem would render great service to scholastic philosophers. Of course, this was not the same as providing the example in question. At any rate, Garrigou-Lagrange did not feel he had overtaxed Duhem by his long letter because he felt encouraged by the kindness (*aimabilité*) with which Duhem had received him in Bordeaux and encouraged him to speak with all confidence.

Garrigou-Lagrange's next letter to Duhem was written three months later, Oct. 15, 1909. By then Garrigou-Lagrange's article "Dieu" had been typeset. He also hoped that he would receive offprints of the very long article (110 columns) so that he might reciprocate the kindness of Duhem who kept sending him copies of his more recent books and articles. Most importantly, Garrigou-Lagrange wrote: "I am much inspired by the long letter you kindly wrote me on the subject [of the principle of inertia]." Inspiration or not, Duhem apparently did not provide Garrigou-Lagrange with a purely physical example of hierarchically subordinate causes acting simultaneously.

Garrigou-Lagrange's gratitude to say the least was somewhat strange. In the article "Dieu" Garrigou-Lagrange devoted 15 columns to the proof from movement,²³ without ever using the expression principle of inertia in his consideration of the objections from mechanics and dynamics. Even when he quoted Descartes' definition of the principle of inertia he did not call it such. This

²³ Art. cit., cols. 1026-1039.

was very different from his letter of July 10 to Duhem where the principle of inertia was an ever recurring expression. Even more difficult to explain is that Duhem was not mentioned when Garrigou-Lagrange brought forth his principal rebuttal of the principle of inertia as a serious objection to the tenet *omne quod movetur ab alio movetur*. The essence of the rebuttal was a reference to Poincaré's *Science et hypothèse* (pp. 112, 161) as a book representative of the view prevailing among contemporary physicists.²⁴ Unlike Newton, Laplace and Poisson, who took the principle of inertia for an absolute truth, contemporary physicists, so Garrigou-Lagrange claimed with a reference to Poincaré's book, took it for a hypothesis suggested by facts though unverifiable by experiments. Would it not have been far more appropriate and sound to refer here to Duhem's *La théorie physique* with which Garrigou-Lagrange was familiar and which gave a far better appraisal of the laws of physics than any other contemporary author?²⁵

Duhem was mentioned in the article "Dieu" only when it came to discussing theologians who tried to incorporate the principle of inertia into a proof of the existence of God.²⁶ Garrigou-Lagrange now quoted a remark made by Duhem at the 1894 Bruxelles Congress of Catholic Scientists: "Let us not use controversial physical theories to establish metaphysical truths." This remark of Duhem, which Garrigou-Lagrange may have heard at the Congress, was of course available in print in the lengthy *Process Verbaux* of the Congress.²⁷ At any rate, Duhem was not mentioned when Garrigou-Lagrange quoted an article, "Théories physiques," by P. B. Lacome, a Dominican, although that article was a defense of Duhem's position on the subject.²⁸

The reasons for Garrigou-Lagrange's slighting Duhem in his

²⁴ Garrigou-Lagrange did not seem to perceive the danger of commodism advocated by Poincaré, who was criticized by mechanists like Cornu and even by Duhem, certainly not a mechanist.

²⁵ For admissions, rather reluctant, of the authority enjoyed by *La théorie physique* at that moment, see *Uneasy Genius*, pp. 353-54.

²⁶ Art. cit., col. 1034.

²⁷ See fn. 13 above.

²⁸ This was all the more curious because the article of Lacome in *Revue Thomiste* (1 [1893], pp. 672-92 and 2 [1894], pp. 92-105) was a defense of Duhem against the suspicion that he advanced an idealist philosophy!

article "Dieu" may never be forthcoming. Garrigou-Lagrange's next extant letter to Duhem (who kept a classified and fairly complete record of letters written to him by physicists, historians, and philosophers) was written almost five years later, March 7, 1914. It began with Garrigou-Lagrange's reference to Duhem's election to the *Académie* on December 2, 1913, with the words: "Especially all thomists now have reason to rejoice." The irony of this will be clear later. Irony was latent too in Garrigou-Lagrange's return to the question of inertia. He was still unsure whether it could be reconciled with Thomas's view of causal instrumentality and in particular with his view of *virtus impressa* in *de Potentia*.²⁹ Again Garrigou-Lagrange brought up the apparent contradictions implied by the principle of inertia insofar as it allowed for an infinitely large effect (unending linear motion) from an exceedingly small impulse. He found the problem all the more pressing as he was working on a book-length expansion of his article in DAFC.

In the same letter Garrigou-Lagrange expressed concern over a statement of Duhem in the newly published vol. 1 of his *Système du monde* which he had bought for the library of the Angelicum in Rome. Duhem spoke of the "yoke of Aristotelian dynamics which modern science had so much trouble shaking off."³⁰ This could hardly please Garrigou-Lagrange, intent on the metaphysical aspect of that dynamics in which he saw fundamental verity. (In 1917, a year after Duhem's death, there appeared the fifth volume of the *Système du monde* in which the 100 or so pages devoted to Aquinas's thought on science and philosophy³¹ contained not a few remarks that could only infuriate any and all Thomists).³² In concluding his letter Garrigou-Lagrange asked

²⁹ Garrigou-Lagrange referred to response 5 in article 11 of question 3.

³⁰ *Le système du monde* (Paris, 1913-59), col. 1, pp. 397-98. In fact Duhem introduced the phrase quoted by Garrigou-Lagrange by a still more severe declaration on peripatetic dynamics: "Nowhere did the misconceptions that vitiated some of its principles produce consequences more contrary to the teaching of experience. Nowhere shall it exercise a more lasting and more pernicious influence!"

³¹ *Le système du monde*, vol. 5, pp. 468-570.

³² For example, "If by Thomism one means a single co-ordinated doctrine which properly belongs to a Saint Thomas Aquinas . . . we can, we believe, firmly offer this answer: There is no Thomist philosophy" (p. 569).

Duhem to write his comments on the margin and send it back to him. Instead Duhem sent back a long letter. This was Duhem's second letter to Garrigou-Lagrange which the latter described as long. Fortunately their inaccessibility³³ does not represent an irremediable problem. First, Garrigou-Lagrange's replies permit a reasonable reconstruction of at least the essence of Duhem's answer to his queries. Second, Duhem could hardly say anything essentially different from his views available in articles and books on the status of physical laws and theories. Third, Duhem's final communication to Garrigou-Lagrange on the subject was printed in late 1914 as an appendix to Garrigou-Lagrange's book *Dieu*.

The gist of that letter is already foreshadowed in the comments which Garrigou-Lagrange penned in his letter of April 6, 1914 to Duhem's second long letter. It is that the principle of inertia is to be studied under three different aspects: mathematical, experimental, and metaphysical. Since mathematics considers only measurable quantities, and experiments relate only to sensible causes, metaphysics is not affected by them. But Garrigou-Lagrange was still not satisfied. He obliquely referred to his own perplexity when he asked Duhem to apply his article of 1894 on "Physique et métaphysique" to the principle of inertia because it could resolve the difficulty of "recent philosopher-converts to Catholicism."³⁴ Garrigou-Lagrange wondered whether the principle of inertia could be considered a mere axiom as Poincaré would have it. Then he set forth his own solution to the problem raised by the principle. The problem was the metaphysical nature of motion as a "becoming" or a process in which a novelty appeared. Such a "novelty," Garrigou-Lagrange argued, could come only from God. He illustrated the situation with a diagram:

³³ In reply to my request for a photocopy of Duhem's letters to Garrigou-Lagrange, the Rev. P. Jose F. Castaño O.P., Rector of the Angelicum, informed me on April 4, 1987 that "le 'carte' del Rev. mo Padre Garrigou-Lagrange . . . costituiscono un *archivio speciale*, il quale è ancora sotto la cura e il segreto pontificio, in quanto la corrispondenza del Padre Garrigou-Lagrange tratta e coinvolge un periodo molto importante e decisivo della Chiesa moderna e in particolare della Santa Sede. Dovrà, quindi passare alcun tempo prima che tale 'materiale' possa essere messo a disposizione degli studiosi."

³⁴ None of those philosophers was named by Garrigou-Lagrange.

1st mover	1st mover	1st mover	1st mover
local motion	heat	local motion	electricity
sensible cause	sensible cause	sensible cause	sensible cause

Garrigou-Lagrange reveals his logical powers when he spells out the consequence, namely, that Thomism implies the non-perpetuity of inertial motion, or the very opposite of the claims of Descartes. "If such was not the case, the formula of the principle of inertia would be an approximate law suggested by experiments and altogether relative to causes that fall within our experience, though susceptible of being completed from a higher viewpoint which alone allows us to speak [of it] in an absolute sense." As an illustration Garrigou-Lagrange offered the following analogy: "Similarly, the sum of energy would remain constant and, yet, the energy would renew itself, just as the sum of human activity remains relatively constant, and yet, humanity is being renewed: God creates souls at every instant." The merit of this hardly precise analogy will be discussed shortly.

Meanwhile, Duhem almost immediately obliged Garrigou-Lagrange with a long letter, for which Garrigou-Lagrange thanked him on April 18. Garrigou-Lagrange was overjoyed because Duhem told him that the principle of inertia was a mere postulate. Garrigou-Lagrange took this to mean that the opposition between the physicist and the metaphysician concerning the nature of motion would finally be eliminated. In fact he found Duhem's letter so satisfactory and significant that he asked him for permission to print it in *Dieu*. Garrigou-Lagrange's next three letters to Duhem (May 4, May 21 and June 10-Pentecost) deal with the particulars of printing. Since the first edition of *Dieu*³⁵ was followed by eleven editions and an English translation, Duhem's letter there became by far his most often printed publication.

³⁵ *Dieu. Son existence et sa nature: Solution thomiste des antinomies agnostiques* (Paris, 1914). The second edition followed in the same year. The eleventh edition appeared in 1950. The English translation, *God. His Existence and His Nature: A Thomistic Solution of Certain Agnostic Antinomies*, was published in 1934-36 (London: B. Herder).

When he saw the book, a second edition of which appeared before the end of 1914, Duhem may have been somewhat disappointed, though not necessarily because his letter was relegated to the end of the book as part of an Appendix.³⁶ Neither his letter, however, nor Duhem's name were mentioned in the footnote informing the reader of an Appendix on the principle of inertia. Nor did Duhem's name appear in the context where (as was the case in his article "Dieu") Garrigou-Lagrange buttressed with a reference to Poincaré the point that the principle of inertia was neither an a priori truth nor an experimentally demonstrated proposition but rather a hypothesis suggested by experiments.³⁷ Duhem appeared in the text in the same way as he did in the article "Dieu", merely a warning voice against exploiting physical theories on behalf of metaphysical tenets.³⁸ A page later Duhem's *Evolution de la mécanique* was listed in a footnote with three other works.³⁹ All of them were to document (rather cryptically) Garrigou-Lagrange's brief recital of various shades of a dynamism so intrinsic to all bodies as to exempt them from any dependence on an external or rather metaphysical actualizer.

Duhem would hardly have been much happier with the fact that just as in the article "Dieu," Garrigou-Lagrange put much emphasis on Emile Boutroux's by then almost 40-year-old doctoral dissertation on the contingency of the laws of nature.⁴⁰ As a keen logician, Duhem, who, as will be seen shortly, made a remark in his letter that stood in contradiction to the ideas of that book, could easily perceive that to use it as a help could amount to a boomerang for purposes of proving the existence of God. In Boutroux's presentation, the contingency in question did not mean that all the laws of the physical world were what they were because their existence was contingent or dependent on a sovereign

³⁶ *Dieu*, 2nd ed., p. 254.

³⁷ *Ibid.*, p. 250.

³⁸ *Ibid.*, p. 256.

³⁹ *Ibid.*, p. 257. The three others were John of St. Thomas, Leibniz, and Kleutgen—a rather strange series to be terminated by Duhem.

⁴⁰ Boutroux's *De la contingence des lois de la nature* (1874) was in its 7th edition in 1913. Curiously, Garrigou-Lagrange ignored the more mature form of Boutroux's thesis, his course given at the Sorbonne in 1892-93, and published under the title, *De l'idée de loi naturelle* (Paris, 1895).

choice of a Sovereign Creator who could have created a universe with other sets of laws. For Boutroux the contingency of those laws stood for possible causal discontinuities, all random, in the physical universe.⁴¹ Such a universe demanded either random interventions by God, a rather Ockhamist notion and very much at variance with Garrigou-Lagrange's Thomist philosophy, or the renunciation of a consistently rational approach to the universe, the very opposite to what was implied in the proof of God's existence from motion. Finally, Duhem would have been puzzled by Garrigou-Lagrange's resolution of the apparent contradiction with the metaphysical meaning of *omne quod movetur*. Garrigou-Lagrange based that resolution on Thomas's notion of instrumental causality⁴² and expanded it with a quotation from the *Physica* of the Thomist philosopher Goudin. According to the latter "the projectile that received the impulse is not at the same time in potency and in act under the same respect; it has in act that impetus, but it is in potency with respect to the position to which it tends."⁴³ To this Garrigou-Lagrange added:

In other words, the projectile is in act as to its dynamic quality and in potency as to its local positions. All contradiction is thereby avoided. This notion of *impetus* that finds in the notion of *live-force* energy its mathematical representation, seems destined to play an essential role in the metaphysics of local motion; this will show how the principle of inertia, whatever truth it contains experimentally, is subordinate to the rational principle of 'no change without a cause'.⁴⁴

While the strength of Duhem in philosophy of science was to emphasize distinctions, he would hardly have committed himself

⁴¹ At the basis of this possibility is, according to Boutroux, the incomplete state of scientific knowledge at any moment. On the faults of this reasoning, see my essay "Das Weltall als Zufall—ein Mythos von kosmischer Irrationalität," in H. Lenk (ed.), *Zur Kritik der wissenschaftlichen Rationalität* (Freiburg in Br., 1986), pp. 487-504 and my *Chance or Reality and Other Essays* (Lanham, Md., 1986).

⁴² See reference in fn. 29 above.

⁴³ The *Physica* of P. Antoine Goudin (1639-1695) was one of the four principal sections of his *Philosophia iuxta inconcussa, tutissimaque divi Thomae dogmata* (1685) whose four volumes were in the 14th edition in 1744 and reprinted several times a century later and even translated into French in 1864.

⁴⁴ Dieu, p. 243.

to the distinction in which Garrigou-Lagrange saw the resolution of the problem posed by the principle of inertia. According to that distinction, "the projectile is in act as to its dynamical quality and in potency as to its local positions." It implied that physics deals only with localization in space. Also, Duhem could see the distinction as a threat to a very central tenet of his philosophy of science, namely, that the progress of physics was a gradual approximation of an identity between its laws and the actual structure and workings of the physical universe.⁴⁵

Last but not least, could Duhem be satisfied with the two pages⁴⁶ in which Garrigou-Lagrange introduced his letter in that Appendix? There Garrigou-Lagrange insisted, again with a reference to Poincare, that no one showed experimentally that a body moving in a vacuum would not slow down by itself even in the absence of any friction. Garrigou-Lagrange again insisted that physics only registered successive stages and forms of energy but never their causal transformation which, according to Garrigou-Lagrange, could only arise from a divine intervention since it implied the appearance of novelty inherent in any becoming (*devenir*). According to Garrigou-Lagrange acceptance of this view imposed on the physicist the duty to recognize that his physical method cannot bear on the metaphysics of becoming regardless of the right of that method to assert itself everywhere in the realm of phenomena.

It was in support of this last point that Garrigou-Lagrange "felt it appropriate and was happy to reproduce a letter of Pierre Duhem of the Academie des Sciences, in which he kindly summed up for us the principal ideas of his beautiful work, *Théorie physique*. We beg him to accept with our thanks the expression of our respectful acknowledgement":

Dear Father: I owe you some explanations for certain ambiguous terms in my previous letter and especially for the name 'axiom' or 'so-called axiom' which I gave to the principle of inertia.

I begin by stating precisely that I shall take the words mathematics, physics, and metaphysics according to the meaning generally

⁴⁵ At the basis of this approximation there lay, according to Duhem, the reality of a "natural classification" of things and processes. See my *Uneasy Genius*, pp. 343-44.

⁴⁶ *Dieu*, pp. 759-61.

given them by our contemporaries, not according to the meaning given them by Aristotle and the Scholastics.

In these circumstances, the law of inertia does not exist for the mathematicians; the principles of the science of numbers and of geometry are the only ones that he has to admit; he is not concerned with the principles of mechanics and physics; if he happens to study the problems presented to him by the mechanist and the physicist, he does so regardless of the way by which they have been led to formulate these problems.

I consider, therefore, the principle of inertia only as it is for the physicist.

One may say of it, then, what may be said of all principles of the mechanical and physical theories. These fundamental principles or *hypotheses* (in the etymological sense of the word) are not *axioms*, self-evident truths. Nor are they *laws*, that is, general propositions reached directly by induction from the teachings of experience.

It may be that certain rational probabilities or certain facts of experience *suggest* them to us; but this suggestion is in no way a *demonstration*; it does not confer on them, of itself, any certitude. *From the point of view of pure logic*, the fundamental principles of the theories of mechanics and physics can be looked upon only as *postulates freely posited by the mind*.

From the ensemble of these postulates, deductive reasoning deduces an ensemble of more or less remote consequences which agree with the perceived phenomena; *this agreement is all that the physicist expects from his postulated principles*.

This agreement confers a certain probability upon the fundamental principles of the theory. But it can never confer certitude on them, for it can never be demonstrated that, if other postulates were taken as principles, consequences would not be deduced which would agree just as well with the facts.

Besides, it can never be affirmed that some day new facts will not be discovered which no longer agree with the consequences of the postulates that had been posited as being at the basis of the theory: new facts compelling us to deduce a new theory from new postulates. This change of postulates has been effected many a time in the course of the development of science.

From these considerations two consequences follow: (1) *We shall never have the right to affirm categorically of any one of the principles of the mechanical and physical theory, that it is true.* (2) *We are not allowed to affirm of any one of the principles on which the mechanical and physical theory rests, that it is false, so long as there has been no discovery of phenomena that disagree with the con-*

sequences of the deduction of which this principle constitutes one of the premises.

What I have just said applies particularly to the principle of inertia. *The physicist has not the right to say it is certainly true*; but still less has he the right to say it is false, since we have so far met with no phenomenon (if we leave out of consideration the circumstances in which the *free will* of man intervenes) that compels us to construe a physical theory from which this principle would be excluded.

All this is said without going beyond the domain of the *physicist*, for whom the principles are not affirmations of real properties of the bodies, but premises of deductions the consequences of which must be in agreement with the phenomena every time that a free will does not intervene to disarrange the determinism of the latter.

To these principles of physics, can we and must we make certain propositions correspond which would affirm certain real properties of bodies? To the law of inertia, for instance, must we make the affirmation correspond that there is, in every body in motion, a certain reality, an *impetus*, endowed with such or such characteristics? Do these propositions apply or not to other beings endowed with free will? These are problems that the method of the physicist is incapable of grappling with and it leaves them to the free discussion of the metaphysicians.

There is only one case which would induce the physicist to be opposed to this liberty of the metaphysician. It is that in which the metaphysician would formulate a proposition directly contradicting the phenomena or a proposition which, introduced in virtue of a principle in the physical theory, would lead to consequences in contradiction to the phenomena. In this case, there would be just grounds for denying the metaphysician the right to formulate such a proposition.

Now you have, Reverend Father, the summary of what I would say if I were ever to write, concerning the principle of inertia, the article that you so kindly wish me to write.

P. Duhem.⁴⁷

⁴⁷ pp. 761-63. In the English translation, pp. 449-51. Here Garrigou-Lagrange added the following note: "Conclusions more or less like those of Duhem are expressed by E. Meyerson. In his *Identité et réalité* (1908), he examines, from the point of view of experience and of philosophic reasoning, the validity of the principles of inertia and of conservation of energy. The author goes so far as to say, what seems to us quite right, that 'the principle of inertia demands that we view *motion as a state*; if motion is a state, it must maintain itself like every state. . . . The

About these statements of Duhem, so clearly and concisely phrased by him, two series of comments are in order. The first series relates to the chief thrust, the other to the measure of completeness of these statements. As to the former, one should note first their witnessing to Duhem's desire and readiness to be as exact as possible in his definitions. Here Duhem the physicist seems to be in debt to the critical queries raised by Garrigou-Lagrange, the metaphysician. It is only in his third long letter to Garrigou-Lagrange that Duhem eliminates any possible ambiguity in his use of the term axiom. He now takes it for self-evident truth, a status which he denies to the laws and hypotheses of physics, and even to the fundamental principles of physics. The latter are "postulates freely posed by the mind." Second, he places the truths of the laws and conclusions of physics, and even the truth of those postulates, in the very wide domain stretching from the categorically true to the definitely untrue.

This policy, which at first sight may reveal a touch of skepticism, is rather a vote for caution and wisdom. It is not without wisdom that Duhem resolutely denies to physics the right to make any statement about reality as such. He had amply learned some major lessons from the history of physics that had seen too many hasty identifications of this or that very successful law with reality as such.⁴⁸ One would only wish that he had explicitly stated that

principle of inertia demands that we view *speed as a substance*. Now this is an entirely paradoxical concept for the immediate understanding. (pp. 132, 134). Professor Gustavo Pécsi, in his *Crisi degli assiomi della Fisica Moderna*, translated from the German (1910), goes further still and believes he can prove absolutely the falsity of the principle of inertia which would end in this contradiction; that motion is essentially motionless, that there is nothing new in it. (p. 201). As to Meyerson, Garrigou-Lagrange should have remarked that the reasons which motivated Meyerson were not from the domain of a realist ontology. The utilization by Garrigou-Lagrange of the way negativist conclusion of Pécsi illustrates a risk of which even the best theologians are not always aware. Agnosticism in respect to physics necessarily entails a sort of agnosticism in philosophy and even in theology. Such is the price an author has to pay, provided he is rigorously consistent in accepting the support of an agnostic position.

⁴⁸ This was the principal reason for his opposition, not so much to atomism, as to mechanistic models of atoms. See my *Uneasy Genius*, pp. 269, 290-91 and 356.

ontology is not the business of physics. This is precisely the gist of his questions as to whether it is permitted to the physicist to attribute to the principle of inertia such an ontologically real property of moving bodies as the principle of impetus or whether the same principle can be extended to free beings. All this could only please Garrigou-Lagrange, the metaphysician, who was there-by granted a great deal of liberty. The only restriction made on that liberty by Duhem, the physicist, consisted in the precept that the metaphysician should not insist on formulating and holding on to principles that lead to experimentally or quantitatively verifiable consequences contrary to sensory evidence.

But were these concessions given by Duhem as complete or desirable as possible? This question leads us to the second series of remarks that may be made about the contents of Duhem's letter. For instance, what was Garrigou-Lagrange, the metaphysician, to do with Duhem's emphatic assertion about the determinism of physical processes? Here Duhem could have been expected to refer to Garrigou-Lagrange's diagram in which a divine intervention is postulated at any change insofar as it is a "becoming" and therefore some plus or novelty. Was that intervention a break in the deterministic chain, and if it was, was it a creation of something new out of nothing, or just another aspect of the general conservation by which God keeps things once created in existence? (Most importantly, was the transformation of local motion into heat or electricity the same ontological novelty as the creation of human souls in very large numbers at every instant?) Probing further into that question would have forced Duhem to wade into ontology, metaphysics, and theology too. Would this have been much of a departure from his championing physics as energetics? Did he not claim that energetics was based on a generalized idea of motion first proposed by Aristotle?⁴⁹

Only three years after the publication of his 2-volume *Traité d'Energetique*, which he considered his crowning work in physics, he drew, and most energetically, a line of demarcation between physics and metaphysics. This may have to do with the even

⁴⁹ Duhem referred in that sense to Aristotle even in his *Notice*, prepared for his election to the Académie des Sciences in 1913. See my *Uneasy Genius*, p. 271.

greater work he was then writing. *Le Système du monde*. Its ten volumes were to corroborate on a vast scale the thesis of his slender volume, SOZEIN TA PHAINOMENA: *Un essai sur la théorie physique de Platon à Galilée*, that theoretical physics was always at its best when its laws and principles were taken as so many purely formalistic statements whose strength was their logical clarity and not their alleged connection with reality.

Early in his career Duhem spoke of that formalistic stance in physics as the one that best served the perfection of physics,⁵⁰ a perfection that he had set as the aim of his life's work. In serving that perfection he concentrated his attention on the markers that could be clearly set up here and there around the true domain of physics. He did not wish to be bogged down in drawing the exact connecting lines between them. This is why he wrote to Garrigou-Lagrange that if he ever were to write that article on the principle of inertia, it really would not contain more than the clarifications contained in his long letter and especially in the last of them.

All this is suggestive of a certain purism on Duhem's part, a purism implying a distinct incompleteness in his dicta. For physics after all deals with reality. Its different aspects can be separated in a conceptual way but they remain inseparable from one another in their actual existence. Things as far as they exist certainly witness to their being and becoming which are not quantitative notions as such. But any physical being and becoming is known through sensory perception which is never without quantitative contents. There is no purely ontological realm as far as material things are concerned, nor can their quantitative features be consistently spoken of as if they were not embedded in a broader and more fundamental kind of reality, the reality of being and becoming.

Therein lies the source of the perplexity or uneasiness of Garrigou-Lagrange, the metaphysician. He did not display sufficient awareness of a fundamental problem as he dealt with the question posed by the principle of inertia for the proof of the existence of God from motion. This is the perennial problem of the one versus the many, in the sense that one and the same thing or process has multiple aspects that are conceptually irreducible to one another.

⁵⁰ See his essay "L'Ecole anglaise et les théories physiques" (1893) in *Prémices philosophiques*, p. 135.

Distinguish them we can, but separate them we cannot. Unite them we must, for knowledge is a quest for unitary understanding. Yet that quest is always fraught with the risk that fusion becomes confusion. That there is no escape from this predicament is probably the deepest lesson to be drawn from the exchange of ideas between a great physicist and a great metaphysician on a basic question of physics which is also a basic question for metaphysics.

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