DIALOGUED PHILOSOPHY[1]

Rationalism and Scientific Dialectics

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I

In following the activity of contemporary physics with attention, in other words with passionate interest, we see a philosophical dialogue come to life that has the merit of an exceptional precision: the dialogue of the experimenter equipped with precise instruments and of the mathematician who strives to closely inquire about experience. While, too often in philosophical polemics, the realist and the rationalist do not manage to speak of the *same thing*, one has the clear and comforting impression that in scientific dialogue the two interlocutors are speaking of the *same problem*. While in philosophy conferences we see philosophers exchange *arguments*, in physics conferences we see experimenters and theoreticians exchange *information*. Should the experimenter not enquire about the theoretical approach to data that the mathematician believes to be strongly coordinated, without which the experimenter could be the victim of personal views in his interpretations? Furthermore, should the theoretician not enquire about all circumstances of the experiment, without which his syntheses could remain partial or simply abstract? Physics, therefore, has two philosophical poles. It is a veritable *field of thought* that is specified in mathematics and in

1 Editor's note: Bachelard's original text, "La philosophie dialoguée," appears in *Le rationalisme appliqué.* (Paris: Les Presses universitaires de France, [1949] 1966), 1-12.

experiments [*expériences*][2] and that comes to life maximally in the conjunction of mathematics and experience. Physics determines, as an eminent synthesis, an *abstract-concrete* mentality. During the course of this work, we will attempt ceaselessly to characterize this mentality in its double action of abstraction and concretion, without ever breaking the hyphen that language imposes, for want of knowing more unified principles in order to *comprehend the reciprocity of dialectics* that move endlessly, and in both directions, from mind to objects.

The meeting point of *experience* and *mathematics* develops into a solidarity that spreads. When it is experimentation that provides the first message of a new phenomenon, the theoretician constantly modifies the reigning theory so that it can assimilate the new fact. With this modification—undoubtedly belated—the mathematician shows that the theory, a little softened, *should have anticipated* the novelty. He [sic] likes to make a display of a sort *of recurrent fecundity* that is—as we will show—an important character of rationalism, for this recurrent fecundity constitutes the ground of *rational memory*.[3] This memory of reason, the memory of coordinated ideas, obeys entirely different psychological laws than *empirical memory*. Ideas placed in order, ideas tidied up and coordinated in logical time, determine a veritable emergence of memory. Naturally, nobody mocks this return, after the fact, to the sources of theoretical prediction, least of all the experimenter. On the contrary, the experimenter welcomes the assimilation of his discovery by the mathematicians. He knows that a novel fact connected to the modern aspect of the reigning theory receives the guaranties of a deeply monitored objectivity, the reigning theory being a system of experimental examination, active in the brightest brains of the era. One has the impression that the problem is *well seen* for the

2 Translator's note: In most cases it is clear that Bachelard is referring to empirical experiments, but there are a few moments, particularly when the discussion veers towards philosophy, when *expérience* could also refer to its English cognate, experience. I have attempted to be judicious in my word choice depending on the context, but ambiguity sometimes prevails.

3 Editor's note: All gendered language from the original has been left unchanged.

sole reason that it *could have been predicted*. The theoretical perspective *places* the experimental fact where it ought to be. If the fact is properly assimilated by the theory, one no longer hesitates on the place it *needs* to receive in a *thought*. It is no longer a matter of a heteroclite or brute fact. It is now a *fact of culture*. It has a *rational status*. It is henceforth the subject of a dialogue between the rationalist and the empiricist.

When it is the theoretician who announces *the possibility* of a new phenomenon, the experimenter, if he feels it is in line with modern science, examines this perspective. This is how, at the beginning of the wave mechanics of the electron, we began searching for a phenomenon that would be, for the electron, equivalent to the phenomenon of light polarisation. Even when a well laid-out investigation is fruitless, it still has a positive effect on epistemology since it helps limit and clarify analogies. Experiments associated in this way with theoretical views have nothing in common with occasional research, with these 'just to see' experiments that have no place in highly established sciences such as physics and chemistry, sciences where the instrument is the necessary intermediary to study a truly instrumented phenomenon, designated as an object of a phenomeno-technic. No physicist would spend their budget in order to build an instrument without theoretical purpose. In physics, Claude Bernard's 'just to see' experiment makes no sense.[4]

What tacit agreement thus reigns in the City of the Physicist! How one moves away from the impenitent dreamers who want to 'theorize' far from mathematical methods! The theoretician must indeed possess the entire *mathematical past* of physics—that is, the entire rationalist tradition of experience. The experimenter, on his side, must know the entire *present of technique*. One would be astonished by a physicist who used an old pneumatic machine to create a vacuum, even if outfitted with a Babinet valve. Modernism of technical reality and rationalist tradition of all mathemati-

4 Translator's note: According to physiologist Claude Bernard (1813-1878), scientific thinking has its genesis in an almost experimentation. It is reported that, after a student stated that he *thought* something was the case, Bernard replied "Why think if you can experiment? Exhaust experimentation and then think."

cal theory; here, then, is the double ideal of culture which must assert itself on all themes of scientific thought.

The philosophical cooperation of the two aspects of physical science—the rational aspect and the technical aspect—can be summed up in this double question:

> Under which conditions can one *account for* a *precise* phenomenon? The word *precise* is, in fact, essential because it is with precision that *reason* is engaged.
>
> Under which conditions can one present *real* proofs for the validity of the mathematical organization of physical experience?

The time of an epistemology that would consider mathematics as a simple means of expression for the laws of physics is past. The mathematics of physics is more *active*. We cannot *ground* the physical sciences without entering into the philosophical dialogue of the rationalist and the experimenter, without responding to the two questions, which are in some manner *reciprocal*, that we have just posed. In other terms, the modern physicist needs a double certainty:

> 1. The certainty that the real is in direct contact with rationality, meriting by this very fact the title *scientific real*.
>
> 2. The certainty that the rational arguments touching on experience are already moments of this experience.

In summary, no empty rationality, no incoherent empiricism. Here are the two philosophical obligations that ground the narrow and precise synthesis of theory and experience in contemporary physics.

This *bi-certainty* is essential. If one of the terms is missing, we can very well conduct experiments, we can very well do mathematics; we do not take part in the scientific activity of contemporary physical science. This bi-certitude can only be expressed by a philosophy entailing a double movement, by a dialogue. But

this dialogue is so tight that we can barely recognize the trace of the old dualism of the philosophers in it. It is no longer a matter of confronting a solitary mind and an indifferent universe. Now we need to place ourselves at the centre where the knowing mind is determined by the precise object of its knowledge and where, in return, it determines its experience with more precision. It is precisely in this *central* position that the dialectic of reason and of technics finds its efficacy. We will try to place ourselves in this central position where both *an applied rationalism* [*un rationalisme appliqué*] and an *informed materialism* [*un matérialisme instruit*] appear. Moreover, we will insist thereafter on the power of application of all scientific rationalism, that is to say, of all rationalism bearing out its fertile proofs in the organisation of technical thought. It is through these applications that rationalism wins its objective values. Therefore, it is no longer a matter—in order to judge scientific thought—of leaning on a universal, abstract, and formal rationalism. We must reach a concrete rationalism in agreement with experiments that are always specific and precise. It is also necessary that this rationalism be sufficiently *open* in order for it to receive new determinations. By living this dialectic, we are convinced of the eminent reality of *fields of thought*. In these epistemological fields, the values of rationalism and experimentalism are interchangeable.

II

In fact, this crossover of two contrary philosophies in action in scientific thought engages many more philosophies, and we will have to present dialogues that are no doubt less narrow, but that expand the psychology of the scientific mind. For example, we would mutilate the philosophy of science if we did not examine how *positivism* or *formalism* are situated, both certainly serving functions in contemporary physics and chemistry. But one of the reasons that makes us believe in the validity of our central position is that all the philosophies of scientific knowledge can be organized on the basis of *applied rationalism*. There is hardly any need to comment on the

following chart when we apply it to scientific thought:

Idealism
↑
Conventionalism
↑
Formalism
↑
Applied Rationalism and Technical Materialism
↓
Positivism
↓
Empiricism
↓
Realism

Let us point out only the two perspectives of *weakened* thought that lead us, on the one hand, from [applied] rationalism to naïve idealism and, on the other, from technical materialism to naïve realism.

In this way, when we systematically interpret rational knowledge as the constitution of certain *forms*, as a simple apparatus of *formulas* conducive to *informing* any experience, we establish a *formalism*. This formalism can, in a pinch, accommodate the *results* of rational thought, but it cannot give the entire work of rational thought. Besides, we do not always keep to a formalism. We have begun a philosophy of knowledge that weakens the role of experimentation. We are on the verge of seeing in theoretical science a set of *conventions*, a succession of more or less *practical* thoughts organized in the clear language of mathematics, which is no more than the *Esperanto* of reason. The practicality of conventions does not take away their arbitrariness. Submitting these formulas, these conventions, this arbitrariness to an activity of the thinking subject will come fairly naturally to us. We therefore approach an idealism.

This idealism is no longer admitted into contemporary epistemology, but it played such an important role in the philosophies of nature during the nineteenth century that it must retain its place in a general examination of philosophies of science.

Indeed, it is only necessary to signal the impotence of idealism to reconstruct a rationalism of the modern type, an active rationalism likely to inform the knowledge of new regions of experience. In other words, we cannot reverse the perspective that we have just described. As a matter of fact, when the idealist establishes a philosophy of nature, he is content to organize the *images* he has of nature, indulging in whatever is immediate in these images. He does not exceed the limits of an ethereal sensualism. He does not engage in an ongoing experience and would be astonished if one asked him to pursue scientific research through essentially instrumental experimentations. He does not see himself as forced to accept the *conventions* of other minds. He does not consent to the slow discipline that *would form* his mind by the lessons of objective experience [*expérience*]. Idealism therefore loses all possibility of accounting for modern scientific thought. The latter cannot find its hard and multiple forms in this atmosphere of solitude, in this solipsism that is the congenital defect of all idealism. Scientific thought needs a social reality, the agreement proper to the City of the Physicist and Mathematician. We will therefore need to establish ourselves in the central position of *applied rationalism* in working to institute a specific philosophy for scientific thought.

In the other perspective of our chart, instead of this evanescence that leads to idealism, we will find a progressive inertia of thought that leads to realism, to a conception of reality as a synonym for irrationality.

Indeed, in passing from the rationalism of the physics experiment, firmly connected to theory, to *positivism*, it seems we immediately lose all principles of *necessity*. Consequently, pure positivism can hardly justify the power of deduction at work in the development of modern theories; it cannot account for the *value of coherence* for contemporary physics. And yet, in comparison with pure empiricism, positivism appears, at least, like the guardian of

legal hierarchy. It gives itself the right to do away with sharp approximations, details, and varieties. But this hierarchy of laws does not have the organizational value of necessities clearly understood by rationalism. What is more, in grounding itself on judgments of usefulness, positivism is already close to declining itself towards *pragmatism*, towards the dust of formulas that is *empiricism*. Positivism does not have what it needs to decide on orders of approximation, to feel the strange sensibility of rationality given by second-order approximations, this more approximate, more discussed, more coherent knowledge that we find in the careful testing of refined experiments that helps us understand that there is more rationality in the complex than in the simple.

As a matter of fact, if we go one step beyond the empiricism lost in the tale of its successes, we reach a collection of facts and objects that, through an encumbering *realism*, gives it the illusion of wealth. Later on, we will demonstrate how the postulate, which assimilates reality to a pole of irrationality and is so easily accepted by certain philosophers, opposes all scientific minds. Once we have brought philosophical activity back towards its active centre, it will become clear that active materialism stops short at all that could be qualified as irrational in its matter, in its objects. Chemistry, armed with its rational *a prioris*, gives us *substances without accidents*, clearing all matter of the irrationality in its origins.

But let us resume this discussion with the use of particular examples. We do indeed believe that the precise examples borrowed from scientific knowledge can *nuance* [*sensibiliser*] general philosophical discussions, as long as we avoid coming to these discussions with rigid philosophical convictions. What we wanted to present in this *philosophical topology* is the keyboard on which most philosophical discussions about science are played. One feature appears striking to us: the diverse philosophical tonalities that we have highlighted form a veritable *spectrum*. What we mean by this is that they arrange themselves naturally in a *linear* order. If we welcome new philosophical sensibilities, it will suffice to expand this philosophical spectrum a little more without having to modify the order of fundamental philosophies. On the other hand, if we

examined other sciences, like mathematics, biology, sociology, psychology, with the same desire to find the elements of a polyphilosophy, we would, naturally, need to establish other spectra for philosophical analysis. Yet no spectrum extends as far as that which helps to classify the physical sciences. It is, in fact, well known that all components of a science are not at the same point of philosophical maturity. Therefore, it is always in relation to well defined experiences and problems that the philosophical values of science must be determined.

III

If we test the philosophical determination of active scientific notions, we will soon notice that each has two sides, always two sides. Every specific notion is a notion that has been specified in an effort of Idoneism, in the Gonsethian sense of the term, driven even further since the dialectics have been more condensed.[5] But these dialectics have already been awakened by the distant symmetries of the chart that we are proposing. In this way, we could already shed light on the epistemological problems of the physical sciences if we established the dialogued philosophy of formalism and positivism. Formalism would already coordinate with enough clarity all of the mathematical points of view informing the positive laws made available through scientific experimentation. Without having the apodicticity of rationalism, formalism has a logical autonomy.

Between empiricism and conventionalism—philosophies undoubtedly too lax—it would still be possible to establish correspondences. Their dialogue would have, at least, the appeal of a double scepticism. They are also highly successful with modern philosophers that observe the progress of scientific thought from afar.

As for the two extreme philosophies, idealism and realism,

5 Translator's note: Ferdinand Gonseth (1890-1975), philosopher and mathematician, proposed a dialectical system renouncing absolute starting points. Instead, inexact, chosen starting points were subject to recursive adjustments according to exact experiences and their principles.

they have hardly any strengths besides their dogmatism. Realism is definitive, and idealism is premature. Neither has the *topicality* [*actualité*] that scientific thought demands. More specifically, it is very unclear how a scientific realism could be elaborated on the basis of a vulgar realism. If science was a description of a given reality, we do not see by what right science would *impose* this description.

Our task will therefore consist of demonstrating that [*applied*] *rationalism* is in no way connected to the imperialism of the subject, that it cannot be formed in an isolated consciousness. We will also have to prove that *technical materialism* is in no way a philosophical realism. Essentially, technical materialism corresponds to a transformed reality, to an amended reality, to a reality that has precisely received the human mark *par excellence*: the mark of rationalism.

And thus, we will always be brought back to the philosophical centre where both reflected experience and rational invention are simultaneously grounded, put briefly, in the area where contemporary science labors.

IV

In these conditions, a philosophy with two *distant* poles, like that of Émile Meyerson, where one determines simultaneously the scientist's attachment to the Real and to the Identical, does not seem to manifest a sufficiently rich epistemological field.[6] To paint the scientist as both an absolute realist and a rigorous logician leads to juxtaposing general, inoperable philosophies. These are not philosophies at work; these are philosophies of *summation* that can serve only to characterise historical periods. With technical progress, the 'reality' studied by the scientist changes its form, losing, in this way, the character of permanence that grounds philosophical

6 Translator's note: Émile Meyerson (1859-1933), chemist and scientist, proposed two static psychological principles for understanding any given scientific theory: the fundamental law-abiding nature of natural events and the necessity of causal relations. Taken together, these lead to a belief in static axes of the *real* order of events and the *identity* of cause and effect.

realism. For example, the 'electrical reality' of the nineteenth century is very different from the 'electrical reality' of the eighteenth century.

On the other hand, no sooner has a reduction to the identical been carried out then the diversification of research begins again. In relation to the identical, it will therefore be necessary to constantly revive the dialectic of the identified and the diversified. The dialectics of analysis and synthesis, of pruning and construction, of selection and realisation will also multiply on reality. A science constantly adjusted, in its principles and subject matter, cannot receive a unitary philosophical designation. It is dialectic, not only in the minutiae of its process, but also in the double ideal of its theoretical coherence and of its experimental precision.

It is perhaps no accident of doctrine that lead Meyerson to a *static conception* of the psychology of the scientific mind. To believe that the state of mind of a pre-lavoisian chemist, like Macquer, would be similar to the state of mind of a contemporary chemist is precisely to shut oneself up in an immobile materialism, in a materialism without dialectic.[7] The history of science is, in this regard, often misleading. It almost never reproduces the obscurities of thought. It cannot, then, get a good handle on rationality in progress. Our existing knowledge so brightly illuminates the past of scientific thought that we mistake all that glimmers for true light. We thus believe in a reason constituted before any effort of rationality. Léon Brunschvieg saw the weakness of this absolute position, and he often insisted on the essential relativity of reason and experience: "We lose sight of the real course . . . of this knowledge when we are concerned with pushing *rationality* and *objectivity* outside ourselves, to end up isolating and opposing the double entity that is *absolute reason* and *absolute object*."[8] We will see that, in

7 Translator's note: Pierre Joseph Macquer (1718-1784), a chemist primarily concerned with the practical applications of chemistry, is now mostly known for his support of the phlogiston theory of combustion against Antoine Lavoisier, the latter being an influential figure in the shift from qualitative to quantitative chemistry, among other long-lasting contributions.

8 Translator's Note: Léon Brunschvicg, *L'expérience humaine et la causalité physique*, (Paris: Bibliothèque de philosophie contemporaine, 1922), 595. Trans-

effect, it is in systematically putting reason and the scientific object in a dialectic of cooperation that we best ensure the rational character of technical materialism and *vice versa* of the real character of applied rationalism. Here still, these are acute approximations that give the object relative stability; they are not the first experiments. Expressed in view of its applications, a rational organization of experience is not the *aim* of a mind that would take its insights solely from the consciousness of the identity of its apperceptions.[9] The intentionality of applied rationalism holds in reserve the possibility of rectifying itself. It is ready, upon application, to receive dialectics that determine resonances even in the principles of organization. In other words, the second approximation does not have the same epistemological structure as the first. It is in the second approximation that the dialectics are truly alert. It is these dialectics that combine the spirit of geometry and the spirit of finesse in a synthesis that is so obviously active in the contemporary scientific mind.

Epistemology must therefore be as mobile as science. In multiplying the number of reciprocal forms that we have called *Brunschvicgian doublets*,[10] we hope to bring together the *coherence* of rational thought and the *cohesion* of technical materialism. But the numerous doublets formed or renewed by Brunschvicg on the Spinozist model of *natura naturans* and of *natura naturata*, as *spatializing space* and *spatialized space*, as the *numbering number* and the *numbered number*, must be even *sharper* in order to account for the strong *coupling* of ideas and experiences that manifest themselves in the development of contemporary physics and chemistry. In this realisation of a strong coupling of ideas and experiences, scientific thought designates itself as a doctrine of *relations* [*rapports*] without *supports* and without a *reporter* [*rapporteur*]. For example, Relativity gives the certitude of effacing absolute time and space and of eliminating

lation mine.

9 Editor's note: Bachelard refers here to the importance for reason given to the 'I think' of the 'unity of apperception' in Kant's *Critique of Pure Reason*, trans. Paul Guyer et al. (Cambridge: Cambridge University Press, 1998).

10 Gaston Bachelard, "La philosophie scientifique de Léon Brunschvicg," *Revue de métaphysique et de morale* 50.1/2 (1945), 81.

the observer.

Epistemology will thereby have to practice dialogued philosophy on the doublets borrowed above all from physics and chemistry, for these doublets make it possible to clarify the traditional discussion on the reality of the sensible world. But we will find numerous occasions to shift the debate a bit. Such will be the case, for example, for the discussion of the duality of the *symbol-symbolising* and of the *symbol-symbolized* in organic chemistry. There is indeed a very remarkable epistemological difference between certain *symbols* that tend only to intuitively translate general knowledge, and certain *models* in which a more realist, more particular knowledge manifests itself. The conventionalism of first representations, as they were proposed in the nineteenth century, made way to a technical materialism that *realizes* schemas.

Likewise, the objectifying tendency of the rational mind is so strong that in mathematics, which aims at the proliferation of the abstract, it is not impossible to detect structures that refer to an objective study. Therefore, there is a place for a post-abstractive experience. Of course, empiricism necessarily flounders if it wishes to place land surveying at the foundation of geometry. Such references are useless in modern culture; they would even be dangerous if such naivetés are not immediately corrected. It is indeed necessary to constitute the subject with rationality, and it is necessary that it accesses *principles of necessity*. In geometry, one does not display [*montre*], one demonstrates [*démontre*]. And the *demonstration* has an autonomy so clear that we cannot receive it from outside, that it does not suffice to 'observe' the result in order to grasp the sense of it. The apodictic character of demonstration does not ordain itself. It is not a fact of authority. It must be followed in its essential discursiveness. One day, as King Charles X was visiting the Polytechnic, he examined with curiosity a hyperboloid design on a tablecloth. The professor wanted the King to understand that this surface of revolution was engendered by a straight line. Having given it his best effort, the professor (his name was Leroy) said to the King: "Well Sire, I give you my word of honor." This word can be likened to D'Alembert's declaration that there is no royal

road to geometry. In order to *understand*, it is necessary here to participate in an *emergence*.

It is precisely such an emergence that is taking place in contemporary physical sciences. Quite different values than observation, convention, measurement, description, and classification have just recently appeared in the sciences of nature. We might as well say that empiricism is an obsolete philosophy. The philosopher who chooses to follow the life of scientific thought in detail will come to know the extraordinary couplings of Necessity and the Dialectic.