
Anti-

Epistemology

after

Bohr and

Derrida

COMPLEMENTARITY

Arkady Plotnitsky

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That this insecure and contradictory foundation was sufficient to enable a man of Bohr's unique instinct and tact to discover the major laws of the spectral lines and of the electron shells of the atom together with their significance for chemistry appeared to me like a miracle—and appears to me as a miracle even today. This is the highest musicality in the sphere of thought.—Albert Einstein

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INTRODUCTION

This study is a joining of two ideas that have shaped the epistemological or, as it turned out, anti-epistemological revolutions of modern intellectual history—Niels Bohr's complementarity and Georges Bataille's general economy. By further coupling both ideas with Derrida's deconstructive anti-epistemology, this book provides a comprehensive the-

oretical framework within which it is possible to relate them and to explore and develop the implications of their conjunction.

Complementarity is drawn from Niels Bohr's interpretation of quantum physics, inaugurated by Max Planck's discovery of the quantum nature of radiation in 1900. The principle and then the framework of complementarity were developed by Bohr in order to account for the indeterminacy of quantum systems and to describe comprehensively, but without classical synthesis, their conflicting aspects. As a physics and *meta*-physics, Bohr's theory enacts a powerful critique or deconstruction of both classical physics and classical *metaphysics*—the classical philosophy of matter. Complementarity was the basis of Bohr's great confrontation with Einstein, and the radical—fundamental and far-reaching—anti-epistemological implications of quantum theory became apparent in the course of this debate.

General economy denotes a mode of theory that relates the configurations it considers to the loss of meaning—a loss it regards as ineluctable within any given system. The concept of general economy was introduced by Bataille and deployed by Derrida, although Nietzsche may be seen as the first practitioner of general economy and Bohr as the second. According to Bataille, "the *general economy* . . . makes apparent that *excesses of*

energy are produced, which, by definition, cannot be utilized. The excessive energy can only be lost without the slightest aim, consequently without any meaning." The general economy is juxtaposed by Bataille to classical theories or *restricted economies*—such as, in particular, Hegel's philosophy or Marx's political economy. *Restricted economy*, however, defines classical theories across a broad spectrum of Western intellectual history: in philosophy, the social and human sciences, history, and other fields. Mathematics and the natural and exact sciences, too, can be seen as restricted economies, when their practice is governed by metaphysical epistemologico-ontological agendas, as they have often been even in the works of many revolutionary scientists, from Kepler to Einstein, and beyond. Restricted economies consider their objects and the relationships between those objects as always meaningful and claim that the systems they deal with can avoid the unproductive expenditure of energy and control multiplicity and indeterminacy within themselves. General economy exposes such claims as untenable.

While other contributions to anti-epistemology—such as those of Freud, Heidegger, Lacan, Deleuze, and Foucault, or Feyerabend and others working in science studies—have been important and will be addressed in the course of the analysis to follow, the present study is specifically concerned with anti-epistemological theories as general economies. I believe the general economic anti-epistemologies to be the most radical theories to date—the theories transforming most radically the spectrum of theoretical possibilities available to us, both in their critical or deconstructive and constructive or theory-building potential.

Nietzsche was the first practitioner of radical anti-epistemology and in many ways his contribution remains unsurpassed. He had a decisive influence upon both Bataille and Derrida, and, although often indirectly, on the whole modern and postmodern theoretical landscape. Bataille's contribution is indispensable as well—by virtue of his introduction of general economy, many of his anti-epistemological ideas, his proximity to Nietzsche, and his impact in Derrida and elsewhere. I shall consider both Nietzsche's and Bataille's ideas throughout this study. My main focus, however, will be on Bohr's and Derrida's theories. These theories may be seen as the culminations of general economic anti-epistemology in their respective fields, and through them the conjunction of complementarity and general economy can be most productively explored and developed.

The analogy between the key anti-epistemological ideas of quantum physics and Derrida's ideas easily invites itself; and this analogy has

been made in commentaries on deconstruction, along with connections, overtly suggested by Derrida himself, between his ideas and Gödelian incompleteness and undecidability in mathematical logic. The goal of the present study, however, is to make the affinities in question specific, rigorous, and systematic, and also to show some crucial differences between deconstruction and complementarity by similarly exploring the conceptual and metaphorical affinities between Derridean and Gödelian theories. As shall be seen, Derrida himself sees his theoretical work expressly in terms of undecidability rather than, and in opposition to, indeterminacy. In this sense—and in the second sense of the word “after”—the anti-epistemology of this study is more *after* Bohr than after Derrida.

Insofar as it relies on the transcendental economy of truth, Gödel's own philosophy of mathematics is classical. Epistemologically, therefore, Gödelian metamathematical undecidability and Derridean metaphilosophical undecidability can be juxtaposed as a restricted and a general economy. From that perspective, Derrida's relation to Gödel can be seen as parallel to Bohr's relation to Einstein. For Einstein can be seen as, in Abraham Pais's words, the grandfather of complementarity, which he resisted all his life. The parallel can in fact be further grounded, historically as well as conceptually. Einstein and Gödel were coworkers in Princeton during the time of the Bohr-Einstein debate, and Gödel made a contribution to general relativity by finding a new solution to Einstein's equations. The Einstein-Podolsky-Rosen (EPR) argument concerning the question of the completeness of quantum mechanics (1935), which played a major role in the Bohr-Einstein debate, may have been influenced by Gödel's terms and ideas, although one must, naturally, keep in mind the differences between them. Bohr, too, on several occasions, specifically refers to the field of mathematical logic and metamathematics; and one cannot, I think, help thinking of Gödelian echos and parallels when the consistency and completeness of quantum mechanics are considered, as they are in the Bohr-Einstein debate. The modern examination of foundations of mathematics, in many ways culminating in Gödel's findings, can be seen as beginning with David Hilbert's *Gründlagen der Geometrie* [*Foundations of Geometry*], published in 1899, although preceding work by Gottlob Frege, Georg Cantor, and others has been crucial to this history. This examination thus, more or less, coincides with the genesis of quantum physics, which begins with Planck's law in 1900, although again preceded by some key experimental and theoretical findings, and culminates with the discovery of quantum mechanics and the develop-

ment of the theoretically consistent interpretation of it around the time of Gödel's theorem. Both the latter and quantum mechanics may be seen as announcing the irreducible incompleteness of knowledge (as classically understood) in their respective fields.

The two sets of relationships themselves—between Derrida and Gödel, and Bohr and Einstein—are not strictly parallel, whether one considers them in historical, theoretical, or institutional (field-specific) terms. For one thing, in the case of the Bohr-Einstein confrontation one encounters a direct debate within a given field, while, in the case of Derrida and Gödel, at issue is a partial and qualified transfer of undecidability as a metaphorical model from one field to another. In addition, Gödel himself saw undecidability as compatible with his classical philosophy of mathematics, while Einstein saw quantum mechanical indeterminacy as incompatible with his philosophy of physics. John S. Bell's work, to be considered in chapter 6 of this study, would offer another example of that type. The metaphysics of quantum mechanics is of course possible, too. As a general economy, Bohr's matrix is not compatible with any form of, in Derrida's terms, the metaphysics of presence or onto-theology, or with their uncritical obverse, positivism, from which Bohr's anti-epistemology must equally be distinguished. Conversely, more anti-epistemological interpretations of Gödelian undecidability are possible, as are more anti-epistemologically suggestive metamathematical theories. As shall be seen, Thoralf Skolem's work on nonstandard models of arithmetics may offer interesting possibilities in this respect.

The relationships between complementarity and undecidability or Derrida's deconstruction thus entail both affinities and differences, or juxtapositions. They are multiply interactive or multiply complementary, in the extended sense of complementarity to be developed here. The task of this study is to foreground such interactions, specifically, the conceptual and metaphorical analogies between quantum physics and Gödelian mathematics, on the one hand, and Derrida's deconstruction and related anti-epistemologies, such as Nietzsche's and Bataille's, on the other. At stake are not so much the analogies themselves, although they are important and will be discussed, but first, the process itself of metaphoricality in theory formation that such analogies illustrate and second, the radical anti-epistemological implications of both this process and resulting models or paradigms. This task forces one to explore the acausal, nondialectical efficacy (the term I shall contrast to the conventionally more causal 'efficacy' here) of both the commonalities and differences—

or complementarities—of the fields involved without attempting to subject them to full, Hegelian synthesis. In order to do so an analysis must itself conform to, interactively, both general economy and complementarity. Such an analysis allows one not only to show the impact of modern scientific ideas and the metaphorical models which they generate in the humanities and social sciences, but also to suggest the possibilities that general economic theories offer for the understanding of modern mathematics and science—their epistemology and anti-epistemology and their functioning. This analysis allows one to introduce general economy into our theories of scientific knowledge and to show that in great measure Bohr has already done so—both by employing general economic thinking and modes of theorizing and by performing a deconstruction, at times quite Derridean, of classical theories in physics and philosophy alike. At the same time, however, Bohr's matrix and his practice suggest, closer to Nietzsche, a theoretical model or paradigm—complementarity—which is not strictly (Derrida's) deconstruction and which enables a critique of certain, possibly residually metaphysical, aspects of deconstruction.

To offer a preliminary outline, complementarity as developed by Bohr enables one to describe comprehensively and employ productively the conflictual aspects of quantum phenomena that cannot be accommodated by classical theories. In Bohr's interpretation such aspects become their *complementary* features—the features that are mutually exclusive but equally necessary for a comprehensive, *complete*, description and analysis of all quantum processes. Bohr speaks of “a new mode of description designated as *complementary* in the sense that any given application of classical concepts precludes the simultaneous use of other classical concepts which in a different connection are equally necessary for the elucidation of the phenomena.” Due to Heisenberg's uncertainty relations, quantum mechanics introduces a certain irreducible—general economic—loss in representation and thus irreducible incompleteness of knowledge as classically understood. Quantum mechanics, however, and specifically complementarity form, as Bohr argues, a complete theory of its data—as complete as a theory can be under these conditions of irreducible incompleteness. Complementarity, thus, connotes both mutual exclusivity and completeness of description, as the word complementarity, which carries both these meanings, would suggest.

Two forms of complementarity are of particular significance in Bohr's framework—one combining that which is always dissociated in classical

physics; the other, conversely, dissociating that which is always united there.

The first is the wave-particle complementarity, reflecting the duality of the behavior of quantum objects and relating the continuous and discontinuous representations of quantum processes. These two types of representation have always been unequivocally dissociated in classical physics. There are two types of objects that are always distinctly identifiable: the discontinuous, particle-type phenomena, such as atoms, or elementary particles, such as electrons; and the continuous, wave-type phenomena, such as light waves or other forms of radiation. In the quantum world, such unequivocal identification becomes impossible. Light, classically a wave phenomenon, acquires a double nature or, more precisely, requires two modes of representation: at times it must be represented as particles—photons—and at other times as waves, but never as both simultaneously. There have been classical corpuscular theories of light, such as Newton's. Prior to quantum mechanics, however, for light and matter alike, there was always either one form of representation or another, never a complementary combination of both. By contrast, in order to develop a coherent interpretation of its data, quantum physics Bohr argues, must employ both representations of light or matter. By the same token, however, one cannot do so in the form of classical synthesis, since one must engage classically incompatible systems of representation without resolving their incompatibility. Bohr's complementarity equally deconstructs both the classical, unequivocal unifications and classical, unequivocal dissociations of features through which physics constructs, describes, and interprets its objects.

The second complementarity is the complementarity of coordination, defining a position or a configuration of positions of a quantum object or system, and causality, classically determining the behavior of such an object or system. This complementarity dislocates the causal dynamics through which the behavior of classical systems is determined and which thus allows one to know with certainty the positions and motion of their elements, such as elementary particles. Or better, it suspends or deconstructs the *claim* of such causality, which claim defines all classical physics and, one might add, all classical metaphysics. Coordination and causality are always united in classical theories, and these theories are in fact defined by this unity. In quantum mechanics, however, in Bohr's defining formulation: "The very nature of the quantum theory . . . forces us to regard the space-time co-ordination and the claim of causality, the union of which characterizes the classical theories, as complementary but exclu-

sive features of the description, symbolizing the idealization of observation and definition respectively." Bohr's word "idealization" is extremely important here. Both coordination and causality must be seen as *idealizations*, symbols, metaphors. This understanding is crucial in defining complementarity as a theoretical matrix and specifically in making it a general economy. In contrast to the classical theories, then, we cannot ultimately establish or calculate, or postulate, the causal dynamics—or, one might say, the history of a system—given the positions of its elements at a given point. The claim of the possibility of this connection may be seen as the postulate of causality, which defines all classical physics. This disjunction between the classically united observation of position and definition of causality leads to what may be seen as the anticausality or indeterminacy postulate of quantum theory. The latter is in fact a consequence of the so-called quantum postulate—the law of nature reflecting the discrete or particle character of light, or of the representation and idealization of light, which must be considered alongside the continuous or wave character, or representation and idealization, of light. A decisive feature of the quantum postulate, however, is that it also implies the acausal character of the quantum behavior of light, as against the causal character of the wave or continuous theory of light. Thus the quantum postulate leads to the anticausality and indeterminacy of quantum theory.

The complementarity of coordination and causality is directly connected to the complementarity of position and momentum, or the kinematic-dynamic complementarity as it is sometimes called, which precludes one from measuring or even meaningfully defining both variables—position and momentum—simultaneously at any given point. By virtue of this connection, the mathematical counterpart of the complementarity of coordination and causality becomes Werner Heisenberg's uncertainty relations. Uncertainty relations may be seen as inhibiting the possibility of obtaining information about some components of a given system, if one wants to increase information about or fully define other components. The term 'indeterminacy' may be preferable to 'uncertainty' in this interpretation, although both terms are used, and 'unknowability' has been suggested as well. Throughout this study I shall use 'indeterminacy' in order to designate a general concept referring to the situation just described. Following common usage, however, I shall retain 'uncertainty relations.' The determination of position, for example, precludes the simultaneous determination of momentum within the same system; and the same relations characterize other structurally paired or, as they are called, conjugate observables of quantum physics, such as time and

energy. One may know one or the other, but not both at once; and, according to Bohr, one cannot even meaningfully consider both variables—position and momentum—as simultaneously applicable or their concepts as simultaneously well defined in the quantum mechanical situation. Bohr brilliantly grasped that this inhibition may be understood in very broad epistemological, or again anti-epistemological, terms as a mutual inhibition and then a complementarity between coordination and causality.

It can be said that uncertainty relations connote a radical, irreducible loss in representation affecting—in advance, always already—any quantum system and ultimately making all such representations idealizations. Bohr directly invokes the inevitable loss of knowledge on several occasions. In terms of the present study, this loss defines Bohr's complementarity as a general economy. This "loss" is so radical that, strictly speaking, it prohibits one from assuming that there is somewhere a complete or unified system, existing in itself or by itself, concerning which system some information is lost in the processes of observation, measurement, and interpretation. As Bohr stressed throughout his writing, the statistical character of quantum mechanics is radical—irreducible—insofar as, contrary to Einstein's hope, it does not imply some "hidden" large complete, unified, and causal system about which quantum mechanics provides partial, statistical information. Quantum-mechanical data is, it is true, mathematically treated in terms of probability or statistics and is sometimes interpreted in this way. As Bohr warns, however, in conceptual terms this language can be misleading. Quantum statistics appears to result from a radical—irreducible—multiplicity, which becomes particularly pronounced in modern quantum electrodynamics and field theory. But such a multiplicity cannot be conceived in classical terms, and it could be contrasted to classical multiplicities, including those of classical statistical physics. Whether in physics or meta-physics, or philosophy, an assumption of a complete large system would restore the classical, metaphysical appurtenance to the interpretive and theoretical framework based on it. One needs instead a very different and more complex economy of difference, exteriority, alterity—general economy. By the same token, the irreducible loss at issue leads to the irreducible fragmentation, the fracturing in advance of any quantum system. One thus is also prohibited from speaking of complete quantum systems, although within its limits quantum mechanics must, as I said, be seen as a complete theory—as complete as a theory can be under these conditions of irreducible incompleteness.

Resulting from the radical loss and fragmentation involved in quantum physics is, thus, not the impoverishment but the enrichment of the emergent configurations. This richness became apparent, beginning with Paul Dirac's pioneering work, in quantum electrodynamics—the theory connecting quantum mechanics and the electromagnetic nature of light and, thus, also Einstein's special relativity. Quantum electrodynamics or QED, as it is often referred to, is the theory most fully confirmed within the available limits of experimental precision. Quantum electrodynamics suggests that if “the very nature of quantum theory forces us” to renounce the claims of causality and the possibility of representation without loss, it also forces us to regard all quantum systems as fields defined by an irreducible, infinite multiplicity and incessant, unending transformations of their constitutive elements. This multiplicity equally redefines one-particle systems, or rather the systems classically defined as one-particle systems—one photon, one electron, and so forth—which are all transformed into irreducibly multiple fields. All quantum mechanical configurations are, thus, simultaneously both irreducibly incomplete and irreducibly rich.

The features just described allowed Bohr to develop complementarity into a comprehensive framework that encompasses both quantum physics and quantum meta-physics—the ontological-epistemological and, as it turned out, the anti-ontological and anti-epistemological dimensions of quantum theory. In this sense, Bohr's *meta-physics* is *anti-metaphysics*, as metaphysics has been developed from (or before) Plato and Aristotle, in their physics and metaphysics alike, to Heidegger, via Descartes, Leibniz, Spinoza, Kant, Hegel, Husserl, and most other major figures in the history of philosophy or intellectual history in general. Aristotle's works after his *Physics*—*ta meta ta physika*—the phrase apparently introduced by commentators on Aristotle to refer collectively to these works, were seen as dealing with things beyond nature or *physis*. These works, however, continued and reinforced the grounding structures defining philosophical discourse as developed before Aristotle, particularly in Parmenides and Plato. Throughout the present study, I shall mean by *metaphysics* this grounding theoretical economy as the metaphysics of presence or onto-theology in the post-Heideggerian, and specifically, Derridean sense, which is more or less equivalent to restricted economy, while the term *meta-physics* refers, generally, to extraphysical considerations, which may proceed by means of general economy.

Heisenberg reports the following remarks by Bohr on Philipp Frank's

lecture in which Frank “used the term ‘metaphysics’ simply as a swearword or, at best, as a euphemism for unscientific thought”: I “began by pointing out that I could see no reason why the prefix ‘meta’ should be reserved for logic and mathematics—Frank had spoken of metalogic and metamathematics—and why it was anathema in physics. The prefix, after all, merely suggests that we are asking further questions, i.e., questions bearing on the fundamental concepts of a particular discipline, and why ever should we not be able to ask such questions in physics?” (*Physics and Beyond*, 210) In view of the history of the term ‘metaphysics,’ however, it may no longer be possible to use it outside its metaphysical-philosophical appurtenance to the metaphysics of presence. Bohr’s meta-physics implies and in fact practices an anti-epistemological general economy of physics, rather than any form of metaphysics developed in the history of philosophy. As such, Bohr’s meta-physics can be used to dislocate all classical or, in terms of the present study, restricted-economic metaphysics, the metaphysics of presence—all its ontology, epistemology, phenomenology, ontotheology, and so forth—and the philosophy of physics that such metaphysics has produced. This dislocation implies that one can neither fully separate physics and meta-physics nor fully unite them, for example, by encompassing physics within philosophy, as Hegel wanted to do. These relationships may instead be defined as complementary, even variably complementary, with shifting border lines between physics and meta-physics.

The *anti-epistemology* of my title refers, broadly, to the general possibility of a dislocation, or as we say now, deconstruction of classical or metaphysical theories—epistemologies, ontologies, phenomenologies, or, to return to Derrida’s more encompassing terms, forms of ontotheology, logocentrism, and the metaphysics of presence. The theoretical base of this dislocation in Bohr’s work is the general economic character of complementarity as a theoretical matrix. This character is, once again, codetermined by the irreducible loss—and thus indeterminacy—in the process of representation and by the equally irreducible heterogeneous multiplicity of all representations that such a matrix generates and employs.

I shall extend the term “complementary features” to various aspects of such multiple and heterogeneous representations, using the complementary features of quantum mechanics as the minimal model for such multiplicities. All general economies deal with arrangements (between and within the configurations they consider) that are complementary in the broad sense of being heterogeneous but interactive—heterogene-

ously interactive and interactively heterogeneous. The latter expression (also applicable to the complementary features of Bohr's matrix) may be understood to mean that, while they multiply interact, the elements or fields engaged in such relationships never allow for a complete synthesis, Hegelian or other.

As I shall argue throughout this study, most specifically in chapter 5, the general economy of asynthesis is a fundamental aspect of Bohr's complementarity, which makes it a profoundly anti-Hegelian, or a-Hegelian, theory. In both Bataille and Derrida, general economy is explicitly defined in relation to Hegel and Hegelianism. Derrida, in fact, uses the name "Hegel" to connote the culmination of the history of the philosophical understanding of interpretive, theoretical, historical, and political processes, the history defining what he calls the closure of the *epistēmē*—the closure of the metaphysics of presence—on which we might still depend even in our anti-epistemological projects and practices. The pervasiveness and power of this closure is one of the main reasons why one is compelled to see general economy as "anti-epistemology."

The dislocation created by a general economy is never a simple or uncritical dismissal of classical theories, but is instead their *rigorous suspension*—an analytical exposure of their limitations and a refiguring of classical concepts through a general economy. In quantum mechanics this relationship to the classical theories is rendered by what Bohr defines as the correspondence principle, "which expresses our endeavours to utilize all the classical concepts by giving them a suitable quantum theoretical re-interpretation." As shall be seen, an absolute abandonment of classical theories—or, for that matter, anything absolute—never amounts to a sufficiently radical transformation of the field, and in a great many cases such a transformation is not radical at all. Radical anti-epistemology and anti-Hegelianism may be defined by their anti-absolutism, whether a positive or a negative absolute is at issue. *Radical* suspensions of epistemology are possible, however. The degree of such a departure from classical theories, specifically philosophy, and the differences between the resulting general economies become interesting and important questions in their own right and are addressed by this study. Radical suspensions do appear to imply the introduction of complementary modes of description and analysis.

This study itself employs a mode of analysis that is both complementary and general economic. In fact, it must do so. The history of complementarity or of general economy, or jointly of both, is itself general economic and complementary, engaging the metaphoric and conceptual traffic between the theories of modern science and the ideas of Nietzsche,

Bataille, Derrida, and several other thinkers. Different fields of inquiry considered by the present analysis must, thus, themselves be seen as *complementary*—interactively heterogeneous and heterogeneously interactive.

In the course of this complementary exploration, I will discuss several major developments of modern physics, which involve the idea and the metaphor of complementarity, and the Gödelian concepts of incompleteness and undecidability in the context of the relationships between complementarity and deconstruction. As a result, beyond exploring the extraordinary conceptual and metaphoric possibilities offered by Bohr's matrix, this study develops a new perspective on the epistemological and anti-epistemological aspects of Bohr's complementarity by interpreting it as a general economy.

At the same time, one must confront the complexity of the interactions between recent, and some no longer recent, epistemological and anti-epistemological developments in, on the one hand, the humanities—or the authors and fields, such as those considered here, more closely related to the humanities—and, on the other, the social sciences and historical studies, particularly recent developments in the history and sociology of science (although, it appears, not quite in the philosophy of science). The argument of this study suggests productive intersections with these latter developments. Such intersections, however, are not always easy given the complex economy of discourse differentiation between such fields, for example, in view of the fundamental relation between Derrida's texts and Continental philosophy. The argument to be offered here must, therefore, negotiate these differences and complexities, and it attempts to do so in part by utilizing them. This book is not written for an exclusively Derridean, or post-Derridean, or deconstructive audience. In many ways its aim is the opposite—to offer the deconstructive line of argument as part of a broader anti-epistemological configuration, which can be represented or, one might say, cross-represented to practitioners in different fields. The extensive treatment of Bohr takes into account the audience in critical theory that may be unfamiliar with Bohr. Conversely, the extended treatment of Bataille and Derrida may be useful to the interested audience in science and science studies. At the same time, however, this book is not an introduction to or a report on Derrida—or conversely on Bohr—but a critical, explorative reading of them and other relevant figures and a work of theory in its own right. Hence I proceed by mutually illustrating Bohr's and Derrida's major anti-epistemological ideas, or by

similarly engaging other figures such as Nietzsche, Freud, Heidegger, and Bataille. The book's aim is to present these figures—and Bohr as a new figure in this landscape—as key anti-epistemological thinkers of modern or postmodern intellectual history and to explore their ideas and the implications of these ideas.

While, however, one must, in view of these considerations, relate the relevant concepts and metaphors in different fields as richly as possible, one also must respect the differences between fields, such as science studies or science itself, in the latter case specifically with regard to the mathematical formalism and experimental data on which modern science relies. My main goal here is to develop *in terms of the present study* an analytic framework suited to the requirements of the humanities and social sciences, rather than to those of the natural and exact sciences. In the latter fields, mathematical or technological results may be independent, or more independent of epistemological or anti-epistemological economies for interpreting them. Certain findings in mathematics and physics, however, would complicate the question; and more recent studies suggest the increasingly complex nature of these relationships, even insofar as their general interdependence is concerned. Certainly, as Bohr's case, or Einstein's—or most major figures considered here—would demonstrate, this independence of mathematico-technological determination does not translate into an analogous independence of the work of a given physicist. Nor does it translate into an independence of the functioning of physics or any other science as a field. Such interactions are much more complex, demanding at the very least a general economy and complementarity. These interactions are, thus, very much within the field of this study, the aim of which is to develop a historico-theoretical framework capable of accounting for—complementary—interactions of that type.