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Spinoza and the Sciences

Edited by Marjorie Grene and Debra Nails

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SPINOZA AND THE SCIENCES

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DEBRA NAILS

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MARJORIE GRENE
DEBRA NAILS

MARJORIE GRENE

INTRODUCTION

Prefatory Explanation

It must be remarked at once that I am 'editor' of this volume only in that I had the honor of presiding at the symposium on Spinoza and the Sciences at which a number of these papers were presented (exceptions are those by Hans Jonas, Richard Popkin, Joe VanZandt and our four European contributors), in that I have given some editorial advice on details of some of the papers, including translations, and finally, in that my name appears on the cover. The choice of speakers, and of additional contributors, is entirely due to Robert Cohen and Debra Nails; and nearly all the burden of readying the manuscript for the press has been borne by the latter.

In the introduction to another anthology on Spinoza I opened my remarks by quoting a statement of Sir Stuart Hampshire about interpretations of Spinoza's chief work:

> All these masks have been fitted on him and each of them does to some extent fit. But they remain masks, not the living face. They do not show the moving tensions and unresolved conflicts in Spinoza's *Ethics*. (Hampshire, 1973, p. 297)

The double theme of 'moving tensions' and 'unresolved conflicts' seems even more appropriate to the present volume. What is Spinoza's relation to the sciences? The answers are many, and they criss-cross one another in a number of complicated ways. I shall not attempt here to enumerate all these interconnections; the arguments that follow speak for themselves. But a glance at a few of the 'tensions' and 'conflicts' may serve as introduction to a rich and, I hope, fruitful group of studies of this transcendent and enigmatic thinker. I started to say "transcendent yet enigmatic", but caught myself: the transcendence is the reason for the enigma(s): if the living face behind the mask, the living person behind the printed texts, evades our questions and our answers, that is not because Spinoza was confused or self-contradictory. The texts, indeed, are often confused or self-contradictory for our understanding.

Marjorie Grene and Debra Nails (eds.), Spinoza and the Sciences, xi–xix.

If their writer escapes us, however, it is not by reason of those superficial contradictions; it is, if we glimpse it at all, the grandeur of the vision behind them that dazzles, and dazes, would-be interpreters. Or so it seems to me; that is why I have the habit (if twice makes a habit) of introducing anthologies on Spinoza, but dare not attempt, myself, to put on paper any would-be explication of his thought. Others, however, fortunately, are more courageous than I, and the present collection adds, I believe, important aids toward our reading of Spinozistic texts, and hence of Spinoza, both in general and in the special context of the sciences, past and present.

Again, our authors are asking, in one context or another, the basic question: what is Spinoza's relation to the sciences? In the spectrum of possible answers to our general question, Maull at the start and VanZandt and Paty at the close provide the alpha and omega. For Maull, Spinoza is a stranger in the age of science: we find in him no kinship with, indeed, hostility to the groping, experimental, cumulative and critical approach from which modern science springs. To put Maull's thesis perhaps too crudely, Spinoza is a rationalist, and modern science is empiricist. For VanZandt and Paty, on the contrary, Spinoza exhibits a deep and moving kinship with the very archetype of The Scientist, Albert Einstein. Nor is this just because Einstein, like Spinoza, was given to metaphysics, as distinct from science. His very science was metaphysically rooted, as Spinoza's was. And more than that, as VanZandt argues, some particular and important doctrines of relativistic science in this century have shown analogies with Spinozistic tenets. So, it seems, in the history of science, rather than being an outsider, Spinoza assumes, three centuries in advance, something like a culminating place.

This startling contrast needs to be further complicated; but meantime, and parenthetically, I must comment on one paradox that arises in connection with Maull's paper. As an author who denies Spinoza's rationalism she cites E. M. Curley, who in his book, *Spinoza's Metaphysics* (1969), had given a superb exposition precisely of Spinoza's 'rationalism', at least as he then understood it. Yet it is true that in his 'Experience in Spinoza's Theory of Knowledge' (Curley, 1973), Curley declared: "The view that Spinoza was a rationalist, in the sense we are concerned with [that is the sense in which knowlege is viewed as purely *a priori*] is not only mildly inaccurate, it is wildly inaccurate" (Curley, 1973, p. 26). On the other hand, in his book, referring to Meyer's

statement of Spinoza's denial of the Cartesian view that "this or that exceeds human grasp", Curley declares: "If rationalism consists in having this optimistic view of man's ability to comprehend the world around him, then Spinoza was plainly and unequivocally a rationalist" (Curley, 1969, p. 157). 'Rationalism' is a weasel word; yet it is clear what Curley means in each case. Spinoza is a rationalist in that he sees "the basic structure of science as being ideally that of a deductive system" (Curley, 1973, p. 58). That is what he argued in his book, and one could find elsewhere, in David Lachterman's essay on Spinoza's physics (1978) for example, a powerful metaphysical grounding of that argument — a grounding I believe it needs. Yet in itself, too, the argument is a careful and convincing one. And the idea of science as a deductive system is not so far, either, from one conspicuous strand in scientific thought. Curley's point in the 'Experience' paper is that Spinoza's deductive system, which culminates, in the third kind of knowledge, in the understanding of an individual thing, needs, at that juncture, explicit grounding in experience. And this thesis is expanded and substantiated in David Savan's contribution to this volume. Yes, Spinoza is a rationalist in his emphasis on science as a system of necessary truths in which the consequences follow necessarily from necessary first principles; but yes, he emphatically recognizes a role for experience and experiment in science, and perhaps, one might even want to suggest, less naively than his correspondent Oldenburg or Oldenburg's friend Boyle. That's another question still open for debate.

In addition to the sharp contrast between Maull on the one hand and Paty and VanZandt on the other, thirdly, yet another position must also be mentioned, and that is the view put forward by Hans Jonas in the brief but provocative essay reprinted here. His view, unlike either that of Maull or of VanZandt-Paty, finds an intimate relation between Spinoza and science, but not the one denied by Maull nor yet that asserted by the last two authors. Spinozistic determinism, Jonas insists, far from anticipating the tenets, or tenor, of twentieth century science, may have furnished the fundamental theme implicit in the view even of those smugly empiricist Newtonians. For determinism was in a sense the theme of classical science until quantum mechanics threatened its sway. Jonas sees in Spinozism, therefore, not an anticipation of twentieth century science, but the dogmatic underpinning of classical mechanics, which only the crisis of quantum epistemology can undercut. And only such a philosophical revolution, he argues, can in turn restore

our everyday awareness of mind-body interaction to its rightful place. Not of course that it was Spinoza himself who spread this baleful determinism: on the whole, nobody read him and everyone condemned him. But as so often happens with truly rigorous philosophical thinkers, it was he (or so I assume Jonas must be arguing) who put into canonical form the radical implications of the then new science that its more respectable exponents not only did not recognize, but failed to notice that they ought to recognize. And there is something in this argument, too. The Cartesian foundation so influential in early modern thought, including scientific thought, was in itself unstable: the clear and distinct idea and its claim to truth, substance and mode, mind/body, will and intellect, God and the world: none of these could remain in the precarious juxtaposition Descartes assigned them. Two outcomes were fated: the philosophies of Spinoza and of Hume — and for neither is the human individual an ultimate metaphysical reality. Yet for VanZandt and Paty, one supposes, as for Cook and Lloyd also, that very Spinozistic determinism epitomizes the grandeur of a free spirit: liberated, as Einstein too was, by insight into the whole of nature. 'Unresolved conflict' or 'moving tension'? Take your choice, as nature, or your nature, determines you to take it. Is Spinoza an outsider to science, a forerunner of the profoundest expression of twentieth century science or even of science as such, or is he the proponent of the true foundations of classical physics, only now overthrown by quantum mechanical indeterminacy?

Short of these wider issues, our authors are concerned, in the main, with special questions bearing on Spinozistic science. True, Spinoza failed to add — indeed, except for the *Treatise on the Rainbow*, made, so far as we can tell, no effort to add — to the increasing body of concrete knowledge of nature that seems to us so characteristic of his century. At the same time, short of the broader themes of Part V below, an examination of Spinoza's place in what we call the scientific revolution proves rewarding in at least four respects.

First, as I have already suggested in my digression on Maull on Curley, Spinoza was the first and most rigorous proponent of a view of scientific knowledge as a comprehensive and deductive axiomatic system. Even though we would deny the logically or ontologically necessary nature of such axioms, some such ideal of an axiom-based, unified science has surely not been a negligible component of the-

oretical science as many have conceived, or perhaps idealized, it. I have heard an eminent philosopher of science declare that, of course, in her view, *every* scientist in all his (her) research is hoping to contribute to a unified science. Being — despite Spinoza — an irredeemable pluralist, I don't believe this for a moment. But it is surely a recurrent theme, not only in the philosophy of science, but among (some) scientists themselves. Indeed, the incomparable Sir Isaac Newton himself excelled not so much in experimental technique or detailed observation, as in unifying what had been disparate problems. Henry Guerlac writes:

> . . . what he gave the world in the body of his scientific work was like the steel frame of some great building. The mathematical laws of optics and celestial mechanics are the girders and supporting members; other men will come with the bricks, the mortar and the cut stone to fill in the walls and lay out the partitions. (Guerlac, 1977, p. 143)

Of course, it was Newton's vision, not that of the Dutch recluse, that set classical physics on its course. But the very difference in vision is worth reflecting on. Newton's unifying vision, Guerlac points out, was basically Gassendist and atomistic. And again that is in the main the way the unity of science movement has gone: for explanation, the least is always the most! As Oldenburg adjured Spinoza:

> In our Philosophical Society, we indulge, as far as our powers allow, in diligently making experiments and observations, and we spend much time in preparing a History of the Mechanical Arts, feeling certain that the forms and qualities of things can best be explained by the principles of Mechanics, and that all the effects of Nature are produced by motion, figure, texture, and the varying combinations of these . . . . (Wolf, 1928, p. 80; Gebhardt IV, p. 12)

The New Corpuscular Philosophy is the way to go. Yet even in the seventeenth century, that is by no means the whole story. What gave Newton's achievement its unprecedented power was not, or certainly not only, its atomism, which, in advance of the nineteenth century, was still speculative; it was the unification of the phenomena achieved through the principle of universal gravitation. As Adam Smith put it in an early essay on the history of astronomy:

> Such is the system of Sir Isaac Newton, a system whose parts are all more strictly connected together, than those of any other philosophical hypothesis. Allow his principle, the universality of gravity, and that it decreases as the squares of the distance increase, and all the appearances, which he joins together by it, necessarily follow. (Smith, 1967, p. 107)

Scope, the sweep of explanation, has always been a scientific value; as traditional interpreters and as some of our contributors have seen him, it was the overriding value on which Spinoza's conception of science was founded.

Second, Spinoza's careful criticism of Cartesian physics forms an important step in the shaping of his own mature science, in what Lachterman (1978) has called "the physics of Spinoza's *Ethics*". This criticism, touched on briefly by Siebrand, is analyzed in depth in Lecrivain's careful study. For the examination of Cartesian science as well as for Spinozistic scholarship it merits close attention. However outlying Spinoza's own life and thought may have been in the advancing physics of his own time, Cartesian science was certainly a major force in the development of classical physics, and Spinoza's criticism of it should not be neglected.

Third, although it was ethical concerns that motivated his work, so that he never focussed as such on the problem of scientific method, Spinoza did hold definite, and complex, views about that question, and did in fact in his own writing put these tenets to work. The essays included in Part II are concerned, in very different directions, with aspects of this problem. Matheron's investigation of the complex relations between Spinoza's arithmetical analogy and the subtleties of Euclidean proofs lends unexpected precision to the distinction between what most of us think of as the second and third kinds of knowledge, or, in terms of the *Tractatus de Intellectus Emendatione*, between the third and fourth. The grandeur of the whole, dazzling though it be, is only confirmed by the delicacy and precision with which its parts have been articulated. But there is another side to the story of Spinozistic methodology: the 'moving tensions' are unending. Savan goes straight to the topic of 'Spinoza: Scientist', with respect to concrete questions of scientific practice. His meticulous examination of Spinoza as working scientist sheds, in my view, floods of new light on this previously obscure topic. In particular, his distinction between what he calls *the principle of detachment*, the (tripartite) *principle of hypothetical explanation*, and the *modelling principle*, allows us to look more concretely and fruitfully than traditional interpretations had permitted at this aspect of Spinoza's thought, in which he stands revealed as a careful, self-conscious practitioner of scientific method in his own time, and even, in agreement with and amplification of Curley's epistemological thesis, as a careful *empirical* worker. Even if the theme of unity,

of understanding through and in the whole, was overriding, especially in the *Ethics*, it was balanced by a scrupulous attention to empirical detail in his specialized scientific work.

What scientific work? the reader may ask. As Maull and Savan agree, Spinoza did little in the way of physical experiment and *qua* experimenter contributed nothing to the history of physics. What traditional history of science has generally overlooked, however — and this is the last of my four points — is that Spinoza *was* a practitioner of science, though not of experimental physics. That is what Savan's paper and the essays of Part III together emphasize. In terms of Agassi's overview, Spinoza was a practitioner of what was to be classical political science. In terms of Popkin's paper — whose consonance with Savan's contribution forms one of the major harmonies of this volume — he was a practitioner of scientific hermeneutics. And that *was* science. Science in this spirit needed, on the one hand, especially for the major intent of an ethics *more geometrico demonstrata*, the excursion into basic physical theory of Part Two, but it needed, on the other hand, the kind of accurate empirical methodology that Savan has analyzed and described so carefully.

Philosophers of biology complain that despite Vesalius, Harvey, Linnaeus and a host of others, the advances in biology from 1543 to 1859 are usually passed over silently by accounts in the history and philosophy of science, and science is equated with the physical sciences. But what about 'social science'? It seems that both those who now propose rigorous programs for these disciplines, subsuming them under 'science' as such, and those who distinguish the 'human sciences' from physics by defending their need for an added interpretive component (allegedly) missing from the more 'objective' fields: both these groups of spokesmen agree that the social sciences are late comers, doing their best, like third-world countries, to overtake their more 'advanced' competitors. After all, as we all know, the *Geisteswissenschaften* were split off from the *Naturwissenschaften* in Heidelberg in about 1900. So as independent disciplines they are recent. What does that suggest for our current subject-matter? That before Rickert and Windelband there was only nomothetic science, which was the science of nature, or perhaps that until that Teutonic secession the study of human nature could be held to flow from, and belong to, the study of nature as such? Surely the latter. Not only Spinoza, but Descartes himself, with his metaphor of the tree of knowledge, believed that the new method, freed

of the shackles of syllogistics, would move straight on from the study of the natural world to the equally precise and reliable study of the human. In Descartes's case the two top branches were to be morality and medicine — if only he had lived so long. In the case of Spinoza, it was two areas of special concern to ourselves and our destinies to which he applied his scientific skills: politics and the interpretation of scripture. But Descartes and Spinoza were by no means the only ones. There was Hobbes; there were Grotius and Pufendorf. There was Richard Cumberland, with his *Philosophical Disquisition on the Laws of Nature*, which grounded its refutation of the iniquitous Hobbes on a method by which, its author declared, the dictates of universal benevolence and all that follows from them, "are reduced to a proper similarity with the propositions of universal mathematics, concerning the effects of mathematical computation, through which all quantities are brought together with one another" (Cumberland, 1672, 2b). These hopes persist, indeed, well into the eighteenth century, with Hume's attempt to introduce the experimental method into moral subjects. The fruit of the new method was to be a new science, not only of nature, but of human nature, not only of those hard solid impenetrable particles out of which God probably formed matter, but of ourselves — and *a fortiori* of those sacred texts on the study of which much of our conduct had been grounded. It is not the would-be scientific study of man that is a late comer, but rather the notion that such a study would not form part of the seamless whole made possible by the new method, mathematical-times-experimental, that leading minds in the seventeenth century, including Spinoza, were struggling to articulate and to apply. Once we rid ourselves, in imagination, of the distinction in kind between 'natural' and 'human' science, we can take seriously, as contributions to the science of his time, Spinoza's research in areas that, though outside the 'exact sciences' in our view, formed perfectly legitimate components of a research program characteristic at least of one very significant group of progressive thinkers in his own day.

In short, while Spinoza contributed to the advance of scientific knowledge neither laws of refraction, nor gas laws, let alone the law of gravitation for which, it seems, the world was waiting, his relation to the sciences, both then and now, is rich and varied. The metaphysical foundations necessary to support an adequate scientific method, the vision of a unified science entailed by such foundationist propositions, the criticism and, partly, correction of Cartesian physical theory, original

use of the mathematical tradition, anticipations of twentieth century doctrines of space and time, the application of a complex investigative method in the emerging field of scientific hermeneutics: all these features are to be discovered when we look at Spinoza in the context of the history of the sciences, from his own time to ours.

April 1984 MARJORIE GRENE

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PART I

SPINOZA AND SEVENTEENTH CENTURY SCIENCE

NANCY MAULL

SPINOZA IN THE CENTURY OF SCIENCE

1. I would like to suggest a context, both historical and philosohpical, for the papers that will follow on detailed aspects of Spinoza's science. My aspiration, however, is not to situate Spinoza among the natural philosophical giants who opened the way to modern science. I cannot conscript him into the ranks of Descartes and Boyle, Leibniz and Newton. Spinoza does not, alas, fit comfortably in the lineup of scientific 'greats', either theoretically or by virtue of some concrete scientific achievement. He was, of course, a great thinker and a great philosopher. But his philosophy was strikingly disconnected from the sifting and interrogating science that went on around him. His own interest in experimental science is well-documented, but it was carefully bracketed from his larger metaphysical concerns. Philosophically, as opposed to biographically, he was as remote from elementary 'doing' of science and especially from the idea of learning by experience as Plato was.

This, of course, is an interpretation, and one that I can support only by pointing to lacunae in Spinoza's writings about science. It is a view I have reached reluctantly, in part because it resuscitates the old clichés about Spinoza's rationalism and his 'God-intoxication'. Bolder and more imaginative interpreters have recently advanced the thesis that Spinoza never was a rationalist (in any 'interesting sense') and that his views about the value of experiment were very close to Descartes's.[1] This, it seems to me, is very far from the truth. Refurbishing an old cliché may even help us to right the balance. However, I remain open to instruction on this point. I shall offer no complete interpretation of Spinoza, but instead a brief list of questions that I believe any interpreter must answer as well as a set of tentative suggestions about how I would go about answering them.

2. The first question is this: Why, if Spinoza sustained a lively interest in experimental science, was he so estranged from it philosophically?

Spinoza first commented extensively on Part II (and a bit of Part III) of Descartes's *Principles.* Only later, at the urging of Lodewijk Meyer

Marjorie Grene and Debra Nails (eds.), Spinoza and the Sciences, 3–13.

and others, did he turn his attention to Part I, the philosophically fundamental opening of the *Principles*. (This is not to say that Part II of the *Principles* is 'experimental', at least in the sense that Part III is. But it does not engage the reader in thought experiments where principles are applied to particular physical situations.)

Again, we know of Spinoza's sustained and scientifically sophisticated correspondence with Oldenburg on various experimental and mathematical matters. In that exchange, Boyle's notions about the chemistry of nitre are discussed, making clear Spinoza's own experimental adventures with potassium nitrate (KNO_3). Huyghens is also mentioned in several letters, and from both letters and biographies we know that Spinoza and Huyghens had many scientific conversations. Leibniz, we also know, recognized Spinoza's mastery of optics, and sent him his 'Note on Advanced Optics' in 1671. Spinoza not only ground lenses for a living, but he also had a thorough understanding of theoretical optics. He wrote an optical treatise on the rainbow and a mathematical work on probability and chance.

Like Descartes, Spinoza lived in seclusion. But he too was surrounded by an astonishing variety of scientific effort, both experimental and theoretical. I have already mentioned Huyghens, who lived nearby. Spinoza who also knew Hudde and Dewitt and must have been acquainted with their mathematical and statistical investigations. Indeed, Spinoza lived and worked in an extraordinary time and place. This Golden age of the Dutch Republic (1585—1695) boasted not only Rembrandt, but Swammerdam, De Graaf, van Leeuwenhoek, and Stevin. Even without the institutional framework for science that developed in England with the Royal Society and Oldenburg's ubiquitous correspondence, the Dutch Republic managed to tolerate and occasionally to encourage a wide range of individual experimental interests.[2]

Spinoza's own daily round of activities, what little we know of it, looks very similar to Descartes's non-philosophical leisure time in the Dutch years: a little experiment, a great deal more thought, some mathematics, and a consuming curiosity about the inner workings of the perceived world. These appear to be precisely the passions and the habits needed to support an active investigation of nature. But the similarity is all surface. While we can credit Descartes with analytical geometry and certain advances in optics, Spinoza made no discoveries, mathematical or natural. The little work on the rainbow, if I am not

mistaken, is not at all experimental; it merely elaborates mathematical calculations made by Descartes. The essay on chance, similarly, is an attempt to solve some problems set by Huyghens. Despite his philosophical differences with Descartes, Spinoza was ostensibly a supporter of Cartesian 'normal science'. Yet consider the character of Spinoza's own experimental work on nitre. It does not seem to have been undertaken in order to understand the internal composition of nitre, but in order to confront Boyle with a philosophical lesson, namely, that (as we would put it) hypotheses are underdetermined by experiment.

3. The critical exchange with Boyle takes the following form: Oldenburg sends to Spinoza Boyle's treatises *On Salt-Petre* and *On the History of Fluidity and Firmness.* Spinoza replies with a rather daunting series of criticisms which he wishes poor Oldenburg to communicate to Boyle. The core of his criticism of the work on salt-petre is this: (1) Boyle concludes, too hastily, and on the basis of experiments alone, that nitre is a heterogeneous body; and (2) a simpler hypothesis, compatible with nitre's homogeneity, can just as easily explain the Boylean results, as well as some experimental outcomes adduced by Spinoza himself. To this Boyle replies, not directly but through Oldenburg, that he never intended a "philosophic and perfect analysis of Nitre", but wanted to show that the "common Doctrine of Substantial Forms and Qualities . . . accepted in the Schools" is weak and indefensible. (This too, is a philosophical thesis, but it is philosophy in the service of experimental science, not in the service of human well-being or of philosophy itself.) Boyle adds, in reply, that Spinoza's own suppositions for the opposite, homogeneity-hypothesis are "gratuitous and unproved" (*Letter XI*, Spinoza (1966) pp. 110—111; Gebhardt IV, pp. 48—49).

In his essay on salt-petre, Boyle had tried to make plausible (or perhaps to demonstrate conclusively) the mechanistic doctrine that heat, color, odor, firmness and the like are the results of bodies in motion. In short, Boyle's explicit concern was the distinction between primary and secondary qualities, and he gave a series of suggestions for how the distinction might be employed in organizing experimental research. (Here and here and here, he points out, it will be possible to explain the secondary phenomena of sensation in terms of the primary qualities of unseen bodies.) Spinoza responded to Boyle's reassertion of a practical and experimental purpose with utter bafflement: if *this* is your idea, Boyle, why are the examples so complicated? Just point out

that water changes its sensory properties when it is steam. In any case, you only illustrate your doctrine and prove nothing. You provide no mathematical proof for this corpuscular philosophy. No proof of mechanistic principles will ever be possible, according to Spinoza.

It might be helpful here to distinguish two strategies of justification, which I shall call (for lack of better terms) functional and demonstrative. Boyle knew that the primary/secondary quality distinction was not susceptible to proof in the q. e. d. sense. It was not a theory to be tested, but a suggestion for the generation and testing of a whole family of theories. He felt that it could be justified in practice, by its fruitfulness in setting out heuristic guidelines for the investigation of nature. Fundamentally indifferent toward the details of nature, Spinoza, by contrast, felt no need to embrace any standard of justification that fell short of deductive proof.

Oldenburgh tried (with some exasperation) to win Spinoza to a more generous understanding of Boyle's purpose: "Our Boyle", he reminds Spinoza pointedly, "belongs to the number of those who have not so much confidence in their reason as not to wish that the Phenomena should agree with their reason" (*Letter XI*, Spinoza (1966), pp. 112–113; Gebhardt IV, p. 50). Spinoza persists: his own hypothesis, opposed to Boyle's, agrees so effortlessly with the experiments and with the mechanical philosophy — what can experiments really tell us? Spinoza's message, conveyed unmistakably in his pesky insistence throughout the exchange, is that the experiments (because they admit to different interpretations) decide no unique hypothesis and that a mechanical hypothesis about the sizes, shapes, and motions of unseen bodies may only be justified by rigid mathematical proof from higher principles. The experiments "which I adduced to confirm my explanation", he writes, do so "not absolutely, but, as I expressly said, *to a certain extent*" (Letter XIII, Spinoza (1966), p. 126; Gebhardt IV, p. 66).

In this passage we may hear (falsely, I think) echoes of Descartes's reminder, at the close of the *Principles*, that for hypotheses about the unseen working of nature we can attain only moral certainty. However optimistic Descartes may once have been about the mastery of nature by reason, he was conspicuously less so by the time he finished the *Principles*. Spinoza, by contrast, seems to have been unswerving in his commitment to proof-as-discovery, to the idea that deduction is the only avenue to an increase in knowledge. From the idea of a thing, he

writes, all of its properties can be deduced (*Letter IX*, Spinoza (1966), pp. 105—109; Gebhardt IV, pp. 42—46). If we are at all interested in the mixing, sniffing, burning, and mucking about of the learned Boyle, it will be only for the compilation of the histories of things. Writing of Boyle's liquids, he says that we do not need fancy experiments to show that the underlying motions of the unseen components of things are rarely detected by human sense. He continues:

> But I do not therefore look down upon this account as useless; but on the contrary, if of every liquid there were an account given as accurately as possible with the highest truthworthiness, I should consider it of the greatest service for the understanding of the special features which differentiate them: which is to be most earnestly desired by all philosophers as something very necessary. (*Letter VI*, Spinoza (1966), pp. 96—97; Gebhardt IV, p. 34)

In sum, Boyle's experiments do not prove the claim that the secondary qualities of seen things are to be explained in terms of the primary qualities of unseen things, nor do they prove any particular hypothesis about those unseen workings in nature. Experiments are unnecessary even as a spur to preliminary assent about the causes of perceived events, for commonplace observations are enough to convince us that there is much hidden from us by the limitations of our sensory equipment.

But the histories or accounts of the experimental phenomena, says Spinoza, will be useful. Why? Descartes would say that they are necessary in order to ascertain which of all possible law-consistent entities and processes actually obtain in the world. But Spinoza's much tighter, deductively bound system (in which all possibilities are actual) seems to require no active investigation into the phenomena.[3] To repeat my leading question: Why, given Spinoza's apparent interest in experiment, is he so estranged from it philosophically? Can the two be reconciled? And if so, is there strong enough textual evidence that Spinoza himself (on his own and not just at our exegetical urging) sees this as a problem requiring solution?

4. When I turn from Descartes's *Principles* to the *Ethics* or to *On the Improvement of the Understanding*, I am struck by Spinoza's ongoing failure to provide us with more than a few, stock examples of what it is to know something.

In *On the Improvement of the Understanding* there is a celebrated

passage (echoed later in the *Ethics*) recounting the "four modes of perception or knowledge" and giving a series of examples to illustrate the modes (Spinoza (1955), pp. 8—9; Gebhardt II, pp. 10—11) "By hearsay [mode one] I know the day of my birth, my parentage, and other matters about which I have never felt any doubt." Secondly, "By mere [vague or vagrant] experience I know that I shall die . . . that oil has the property of feeding fire and water of extinguishing it . . . that a dog is a barking animal, man a rational animal, and in fact nearly all the practical knowledge of life." These first two categories comprise what Descartes called in the first Meditation knowledge "of the senses or by the senses". The second mode seems to correspond to the experimental or observational histories that Spinoza calls useful.

Thirdly, we "deduce" that mind "is united to the body, and that their union is the cause of a given sensation; but we cannot thence absolutely understand the nature of the sensation and the union". Or, Spinoza continues,

> after I have become acquainted with the nature of vision, and I know that it has the property of making one and the same thing smaller when far off than when near, I can infer that the sun is larger than it appears and can draw other conclusions of the same kind.

This third mode of knowledge seems to involve causal thinking or causal attribution. It stands, as a category, rather uneasily between habitual inductions (dog as barking animal) and the truths of intuition. It is an uneasy 'middle ground' that involves deduction, or reason (as opposed to intuition.) This third sort of knowing is the locus of Descartes's mere 'moral certainty' and it is the category in which we find the good experimental hypotheses about bodies unperceived or not fully perceived. We find, for example, Descartes's assumptions about light explicitly acknowledged as hypotheses in the opening pages of the *Dioptrics*. To such hypotheses we can attach only moral certainty.

But for Spinoza, the sun's size, once properly understood, is a statement necessarily true. The sun is not the size it first seems when seen. When we understand the inner workings of vision, we also understand that the sun is larger than its perceived image would lead us to believe. The necessary truth is deduced from the right rules but this 'deduction' is further distinguished by Spinoza from the fourth mode of knowledge which also affords necessary truth: "the perception arising when a thing is perceived solely through its essence or through the

knowledge of its proximate cause". If "from knowing the essence of the mind I know that it is united to the body", I have knowledge of the highest, intuitive sort. Notice how easily the third mode of knowledge might be confused with the fourth. Descartes purposely elides deduction and intuition — intuition is a very fast deduction. But Spinoza, as I shall explain later, suspects that these two operations of the mind may be very different. He insists on the qualitative psychological and epistemological difference between having the right rule that gives the right answer (mode 3) and knowing the essence of a thing (mode 4).

This taxonomy of knowledge is taken a step further both in *On the Improvement of the Understanding* and the *Ethics*. Spinoza rehearses the four ways of knowing by reference to four ways in which a mathematical proportion may be calculated. The range of knowing (from hearsay to rule of thumb, to deduction or having the right rule, and finally to intuition or 'just plain knowing') is repeated.

And in a later passage of *On the Improvement of the Understanding* Spinoza (1955, p. 26; Gebhardt II, pp. 26—27) tries to give us a better notion of the object of intuition, or better, of the mental event that constitutes "just plain knowing." He explains that "a true idea is distinguished from a false one, not so much by its extrinsic object as by its intrinsic nature", and "If an architect conceives a building properly constructed, though such a building may never have existed, and may never exist, nevertheless, the idea is true . . .". Truth is not a relation between ideas and things but depends "solely on the power and nature of the understanding".

This, it seems to me, is a perfectly familiar account of mathematical objects. But it is a queer avowal for a man who insists on the usefulness of compiling histories of phenomena. Is Spinoza interested only in what was then called the objective reality of ideas? What about the multiple connections between mathematical objects and the phenomena of experience?

Contrast Spinoza's attitude with Descartes's worries about the application of mathematics to nature. Descartes tries to solve the problem of applying mathematics to nature with the primary/secondary quality distinction and with his theory of perceptual judgment. By present standards, these attempts may be philosophically misguided. But for early modern science, the effort was developmentally crucial. All this is patently absent in Spinoza, who merely alludes to the problem in the so-called Physical Digression of the *Ethics*. The lengths

In response to Tschirnhaus's second question, whether the particular bodies of our experience can be deduced from extension alone, Spinoza (who was admittedly weary and ill) replies, no, not if it is Cartesian extension but yes, if it is extension properly conceived. He contiunues, "But perhaps, if life lasts, I will discuss this question with you some other time more clearly". As to Tschirnhaus's allegations about the limits of definition, Spinoza says:

> This may be true in the case of the most simple things, or in the case of things of reason (under which I also include figures) but not in the case of real things. For from the mere fact that I define God as a Being to whose essence belongs existence I infer several of His properties, namely, that He exists necessarily, that He is unique, immutable, infinite, etc. And in this way, I might adduce several other examples which I omit at present. (*Letter LXXXIII*)

In Spinoza's last months there is only the answer "Yes" to Tschirnhaus's question about the possibility of *a priori* knowledge of determinate things. Did Spinoza truly believe that scientific knowledge could be gained without experience?

5. My skepticism about Spinoza's philosophical interest in the problems cast up by the development of modern science is, I think, open to two kinds of responses. One important sort of answer would resort to the central issues of truth and adequacy in ideas, and would compare Descartes and Spinoza in this respect. Ultimately, I think, such a response would reconstruct for us the vision of science that Spinoza *might* have conceived, had he our questions in mind.

A second answer would *start* by accepting the premise of Spinoza's radical departure from the epistemological concerns of his natural philosophical contemporaries and address itself to the larger goals of his enterprise. It would note that there is an epistemological agenda associated with the rise of modern science, an agenda to which Descartes, Locke, Newton, Leibniz and even Berkeley and Hume adhere: the primary and secondary quality distinction, the theory of perception and of correct perceptual judgment. About these questions, the learning-about-nature questions, Spinoza has conspicuously little to say. But because he is so passionately concerned with the idea that human well-being is afforded by knowing the whole, he has a good bit to say about causality, possibility, essences and the central metaphysical issues of concern to science. For Spinoza, God may well inhabit the architectural details — the details of determinate natural things — but

believed, by isolating items from disturbing influences. On the ancient and medieval view of science, which Spinoza shared, the principle beneficiary of knowledge was the knower. Bacon, Descartes, Galileo, and Newton all had a different view. They believed that the benefits of scientific knowledge would be distributed equally among scientists and non-scientists. This shows that they had a narrower, less morally-encumbered, idea of knowledge than that advanced by the great philosophers of an earlier age.

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NOTES

[1] "The view that Spinoza was a rationalist, in the sense we are concerned with, is not just mildly inaccurate, it is wildly inaccurate," writes E. M. Curley (1973, p. 26).

[2] These scientific developments are discussed in Struik (1981).

[3] Indeed, Spinoza suggests that the scientific understanding of nature is by no means an amplitive process, but rather a precarious attempt to apply principles already known by the light of reason. In the *Tractatus Theologico-Politicus* he likens the interpretation of nature to the interpretation of scripture, with all the attendant pitfalls.

[4] *Letters* referred to in the following section (*LXXX–LXXXIII*) are found in Spinoza (1966, pp. 361–365; Gebhardt IV, pp. 331–335.

[5] See, for example, VanZandt's essay in this volume.

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have had of the science of nature, insofar as he may actually have acquired it through his recent continuation of the work of Galileo and Descartes, without excluding the research of the man who was his neighbor from 1663 — the date of publication of the *Principles of Descartes's Philosophy* — the Dutch physicist Huygens. This question also encompasses comprehension of the relation between this type of epistemological description and the whole philosophical project that nourished and provided originality to the evolution of Spinoza's thought.

1.1. *Reasons for Spinoza's Interest in Cartesian Mechanics*

Without going into detail, let us just say that three interests may have motivated Spinoza's orientation. First, his choice was probably determined by the methodological efficaciousness of the Cartesian conception. It appeared to Spinoza that Cartesian physics and the theory of mechanics expounded there could be considered as useful intellectual instruments for guiding and sustaining the elaboration of his own thought. Probably more profoundly, Spinoza's interest could have been awakened by the importance of the new field of rationality constituted as much by the results of Galilean research as by the shift toward universalization conferred on them by Descartes's forging of a new mathematical tool — analytical geometry — and his efforts to provide metaphysical legitimacy. However, access to his new field of knowledge occurs for Spinoza in the years 1663—1665 *via* a set of mediating abstractions. Abstract, first, insofar as it is a system of conceptual elements already elaborated through which the idea of nature displays a new significance that definitely removes it from the Aristotelian-Scholastic context, now relegated to the prehistory of science. But equally abstract in the sense that mathematics and physics were not for Spinoza — despite his undeniable competence in the field of optics — sciences that he practiced for themselves, but were more useful as tools in conditioning his theoretical apprenticeship. As he says in his last reply to Blyenbergh (*Letter XXVII*), ". . . Ethics . . . must be based on Metaphysics and Physics" (Spinoza, 1966, p. 199; Gebhardt IV, p. 160). This is because the fundamental project of the philosopher remains that of constituting a theory of the affects and human behavior inspired by the model of rationality furnished by the sciences of nature. One can add to these diverse reasons a final motivation from the

mathematics a basis in things. It treats at least a few aspects of perceptible objects and does not deny itself recourse to experimental procedures to give an account of the motion of the pendulum, falling bodies, or the resistance of materials to rupture (Galilei, 1952, pp. 131—177). For its part, the Cartesian analysis already attempts to universalize the results of Galilean science in affirming, for example, that the laws of nature are homogeneous and immutable and in demonstrating, by means of analytic geometry, that all the elements of space can be composed and ordered effectively in accordance with the laws that regulate algebraic operations. Combining the one with the other, Galilean physics with Cartesian mathematics, one glimpses why and how extension* can be considered as the ultimate framework of things, decipherable with the aid of geometrical figures and algebraic symbols.

Spinoza clearly marks, within this evolution of thought, the presence of two themes that he concentrates on removing. First, we can know only the relations among extended things or among the ideas of these things. And this is indeed why the understanding, defined as the order and connection of ideas, gives an effective content to the category of attribute. In the second place, it is clear that the universal concept of substance must be recognized as the principle of intelligibility of the laws of nature. Under these conditions, the concept of the infinite becomes expressive of the immanent presence of a rational order actually within things. This implies not only a complete revision of the meaning of the infinite, just as much in relation to the Scholastic tradition as to the Cartesian heritage, but the identification of substance with the infinite productive power of nature — in short, the demonstrable and verifiable affirmation that the infinite is nothing but the actual being of nature. Without being able to develop these two points in detail, let us just say that the concept of the infinite loses henceforth the meaning that previously had been conferred on it by faith or theology — which established the character of incomprehensibility that even Descartes gave it — to attain henceforth an integrally natural and rational significance. Nevertheless, there remains the problem of this new concept of infinity's mode of relation to and compatability with the diverse procedures operating in the sciences of nature and especially in mathematical physics. Indeed, as indicated by *Letter XII* (Gebhardt IV, pp. 52—62), one must acknowledge a careful and rigorous distinction between the different senses of the term 'infinite' according to what is legitimately and adequately known by the understanding or appre-

hended only by the imagination. If substance and its modes constitute the totality of things really existing, the being of nature is not entirely reducible to the indefinitely divisible magnitudes in accordance with numbers, or to the durations expressed by the relations of time. Thus the question arises of the determination of the status of the operating instruments used by physicists and mathematicians engaged in the practice of the mathematization of nature.

1.3. *Modalities and Validity of the Process of Abstraction in the Sciences of Nature. Determination of the Status of the Abstract Operators: Time, Number and Measure as Auxiliaries of the Imagination*

The very object of physics is bodies in motion, striking and repelling one another, and their natural being would be destroyed if one did not begin by recognizing the infinite unity of productive motion in its inexhaustible diversity. If one did not admit this preliminary condition, the meaning of the physical law would be compromised because the successive positions of the moving object could no longer be linked to one another and, by the same blow, ineluctably, the paradoxes of Zeno would reemerge. Undoubtedly, Descartes himself did not completely escape this, for he was tempted to combine motion with rest, the dynamic with the static. But, to the contrary, without the auxiliary notions of time, measure and number, no physico-mathematical science of nature is possible. Thus it is appropriate to determine their functions rigorously and to recognize the role strictly appropriate to each, an investigation clearly involving the objectivity and rationality of natural law.

Consequently, it is important to explicate the process of abstraction that corresponds to the intervention of these operators, those that permit the clear and exact expression of motion in itself inseparable from the object studied. So one must take care to make these abstract instruments real or natural and to convert them into real properties of things: if one yielded to that fiction, which would mark the triumph of imagination over understanding, the modes could be considered independently of substance, from which they hold all their power of existence, and they would then be found unduly substantified. The principal teaching of *Letter XII* consists in making us comprehend how imagination perverts our knowledge of things by transforming operative

possibly somewhat courageous to deal with important questions; but, he asks, is it any use to be courageous if it comes to nothing?

Trying to superimpose Einstein's and Spinoza's thought one on the other would result in a similar misunderstanding. Each is relative to its own distinct context, to its own perspective and requires, for its elaboration, the proper use of its own concepts. What is needed, therefore, is the consideration of the peculiar logical structure of these two kinds of thought, respectively; only in this way can we find similarities — or differences — that are really significant, and only in this way can we understand how and why the deep logic of Einstein's thought meets the deep logic of Spinoza's. There is no interest in asking whether Einstein is reasoning in terms of attributes, essences and modes; and it would be meaningless, for these are not his philosophical categories. What matters is to know whether the conceptual ensemble that Spinoza developed in order to manifest the ground, range, and truth value of a philosophy of the world would not find some kind of resonance in a thinker like Einstein — I say, indeed, a thinker, and not only a scientist. . . . Now, it is indeed highly instructive to note that, notwithstanding the great difference in their respective historical and philosophical environments, as well as in the problematics of the philosophy and of the science of their times, Einstein and Spinoza join together deeply in the following concerns: the significance they both attribute to their investigations, the relation they assign between thought and nature, the possibility of attaining a knowledge of nature and of acting on it beyond the possible content, quite different indeed, of these two styles of knowledge each in its own right.

Far more than the Spinozistic sources of Einstein's thought, what concerns us here is a convergence of themes and manner of approach: both are assimilated to Einstein's personality as well as to Spinoza's and these are not to be identified with a tradition or with influences, on which they are, however, obviously dependent. But both set, rebuild and reinvest the elements of their quest, by themselves and in an original way. If we want to give meaning to such a question as *to what extent is Einstein's thought Spinozistic?* we must understand 'Spinozistic' not as a model, a system, or even a tradition, but as a way of being, as a thinker, in the world.

Those who have had this experience of finding themselves Spinozistic without having intended to be, can say with Romain Rolland that what they find when reading the text is nothing but themselves:

in the inscription written in the opening passages of the *Ethics,* in these definitions written in blazing letters, I deciphered not what he said, but what I meant to say, those words which my own childish thought tried to spell out from its inarticulate tongue. (Rolland, 1980, p. 285)

If it has meaning to say that somebody nowadays finds himself close to Spinoza, it is probably in such a sense; I mean when someone has reflected starting from intellectual practices which can be very different — physicists, Maxists, modern lens-polishers. . . . In this respect it is highly remarkable that problems set out by contemporary scientific knowledge often bring back on the scene Spinoza's conceptions, as we shall see, notably from the point of view of methodology, and without any artificial projection or reduction. Such is precisely the "actuality of Spinoza's thought", beyond any erudition, which will emerge from a confrontation with Einstein's conceptions — Einstein who is not, I insist, contrary to what has often been said, the last nineteenth century scientist (though indeed his personality and his type of quest are at variance with his time), but whom I consider as one of the beacons of contemporary scientific thought.[12]

2. EINSTEIN'S EXPLICIT REFERENCES TO SPINOZA

I shall now consider for a moment the explicit statements of Einstein about Spinoza, although we know that Einstein's Spinozism is not that of a scholar and that it is a question not so much of influence as of resonances or affinities of his thought with Spinoza's.[13] These statements are numerous and short, scattered in various essays, in interviews with the press, and, mostly, in his letters to his friends and to the innumerable correspondents who wrote to him from all over the world to get his opinion, not about scientific questions, but on daily problems concerning existence, life in society, peace, God. . . . These letters, gathered at the Einstein Archives, some of which already have been published by Banesh Hoffman and Helen Dukas (1979), touch on this aspect, revealing the deep humaneness of that man who was something of a myth for some people. Spinoza is often invoked in these letters, as if Einstein had a daily familiarity with him. The peom entitled 'for Spinoza's *Ethics*', written in 1920, begins, "How much do I love that noble man/more than I could tell with words. . ." (Einstein Archives, unpublished). In 1921 he happened to go to Vienna, and on this occasion went to visit the philosopher Josef Popper-Lynkeus, a socialist

of Jewish origin, who was a friend of Mach and whom Freud also admired, speaking of him as "one who came as near to being a man 'wholly without evil and falseness and devoid of all repressions' as he had ever heard of" (quoted by Feuer, 1974, p. 57).[14] Popper-Lynkeus was at the time an old man of eighty. Einstein took note of this meeting, and its sounds like a *cri du coeur.*

> So much goodness and mildness! When he entered, I thought at once: it is Spinoza! Such a physiognomy is only to be found in Jewish people, indeed among Jews we find the most extreme contrasts. At most among Italians would we find such a face. I mean among Italian saints: Francis of Assisi, for example. (Einstein Archives, unpublished)

To a Brooklyn Rabbi who asks him about Maimonides's philosophy and relativity, he answers first that he has never read Maimonides and that the theory of relativity has nothing to do with this kind of philosophical discussion, and then writes, "Answering your questions would fill up many books [. . .]. I can only say in a few words that I share exactly Spinoza's opinion and that, as a convinced determinist, I have no sympathy at all for the monotheist conceptions" (letter to Rabbi A. Geller, September 4, 1930, Einstein Archives, unpublished). To another correspondent, in 1932, "all that I think of that extraordinary man, I can express as follows: Spinoza was the first to apply with true consistency to human thought, feeling and action, the idea of the deterministic constraint of all that occurs" (letter to D. Runes, September 6, 1932).[15] On another occasion he notices that a limited causality "is no longer a causality, as our wonderful Spinoza was the first to recognize with all precision" (letter to E. B. Gutkind, January 3, 1954, Einstein Archives, unpublished). Questioned about God, he answers, "I believe in Spinoza's God, who reveals Himself in the orderly harmony of what exists, not in a God who concerns Himself with fates and actions of Human beings" (*The New York Times,* April 25, 1929, p. 60, col. 4, as quoted in Schilpp, 1951, pp. 659—660).

In 1948, to Michele Besso, who talked about the love which should be given to one's enemies, he wrote, "For me, however, the intellectual basis is the belief in an unlimited causality. << I cannot hate him, because he *must* do what he does.>> Consequently I am nearer to Spinoza than to the prophets. This is the reason why, for me, there is no sin" (Einstein, 1972: letter of January 6, 1948). And his friend, shortly before Einstein's death, answers him like an echo, "You profess to admitting Spinoza's God; this impels me to take *The Ethics* once again into my hands. . ." (letter of January 29, 1955).