The Character of Howard Stein's Work in Philosophy and History of Physics

Abner Shimony, Boston University (Emeritus)

The publication of this Festschrift to Howard Stein is an occasion for celebration in several professions: philosophy of science, history of science, general philosophy (especially epistemology, methodology, and metaphysics), and physics. His masterful interweaving of considerations commonly parceled out to these disciplines is a major reason for the unique value of his papers. Unfortunately, it has also been responsible for the fact that he is more widely admired than read, because his analysis and writing make demands that readers cannot meet without some knowledge of all of these disciplines, or at least a willingness to make an effort to follow argumentation drawn from them all. This Festschrift should draw in potential readers by acknowledging the inspiration of Howard's papers, by citing and amplifying some of his ideas, and in some cases by showing concretely how to use his suggestions for further research. It should be said, however, that Howard is the best commentator on his own work -- as he somewhere said of Newton. Consequently, an even more useful guide than this Festschrift will be the collection, projected for the near future, of Howard's papers on Newton and other physicists and philosophers of that epoch. The unity of themes that bind the individual papers together ensure that one paper supports another, and passages that are condensed in one paper (usually because of limitations of time and space in conference proceedings) are made more accessible by leisurely expositions elsewhere in the collection. It is, of course, to be hoped that Howard's work on later science, especially relativity theory,

quantum mechanics, and foundations of mathematics, will also be collected in the not-too-distant future.

Any one who reads Howard's papers with even moderate attention cannot help but be impressed by the closeness of Howard's analysis of classical texts of physics and classical

writings on natural philosophy. HERE Howard is, to my knowledge, the *only* analyst of classical physical texts from a philosophical point of view whose standards are comparable to those of the critics who have raised the close reading of literary texts to a high art.

There are specific procedures which deserve to be mentioned in Howard's practice of analysis, and I shall come to them soon. HERE But the excellence of his analysis depends primarily on two features that are not procedures, but rather analogues to the love of poetry in a fine poetic critic.One is that Howard is profoundly respectful of the intellectual achievements of Galileo, Huygens, Lagrange, Riemann,Maxwell, Lorentz, Einstein etc., and above all of Newton, and he strongly feels that the reflections and interpretations which these giants offer concerning their own work deserve careful study (contrary to well known depreciations of the philosophical acumen of certain great scientists). The other feature is his passion to *understand* -- where the object of understanding may be a linguistic expression, a thesis, a mathematical demonstration, a scientific discipline, or a commentary. An indication of this passion is the amount of time I have seen him bestow on reworking proofs of generally accepted mathematical theorems, in order to achieve versions that seemed transparent to him -- with apparently no worry that the effort thus expended might distract from research that could lead to

publishable novelties. HERE In a highly competitive world, his choice of understanding over the prestige of discovery is extremely rare. But I am happy to say that his virtue was rewarded, for his passion to understand passages that have been dismissed as idiosyncratic or naive in classical writings (e.g., Newton's "Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external") has often led him to fine innovations of interpretation and in some cases to genuine conceptual discoveries.

HERE As to procedures of analysis, each of the following has been essential to Howard's work, and their combination -- rare and probably unique -- has been extraordinarily illuminating.

(1) He freely uses relevant parts of modern mathematics and physics in order to explicate texts and to comment on disputes of previous centuries. For example, "Newtonian Space-Time" begins with two characterizations of the structure of the space-time implicit in Newton's dynamics: one using concepts of affine geometry articulated in the twentieth century geometry (especially by Cartan), and the other using the concept of Galilean invariance in a way that was not articulated fully until the end of the nineteenth century (by Lange). These characterizations are not window-dressing, but are used to clarify efficiently the points at issue between Newton and Leibniz and between Newton and Huygens, and in the case of the latter dispute to show how both disputants were partially correct and partially incorrect in their claims regarding absolute and relative motion. The efficient deployment of modern geometry and physics obviously requires an understanding of these disciplines, and it also presupposes rejection of the widespread opinion among historians of science that it is

anachronistic and "Whiggish" to bring contemporary scientific knowledge to bear upon disputations of an earlier epoch.Tangentially, in the first lecture of one of his courses at the University of Chicago Howard reminded the class of the maxim supposedly inscribed over the gate of Plato's Academy, "Let no one unacquainted with geometry enter here"; he said that he did not make that requirement, but did demand that no one *emerge* from the course unacquainted with geometry.

(2) Howard is nevertheless as obsessive as a professional historian in seeking out the context of intellectual debates of a previous epoch. An amusing case of this obsession, of no importance for the conceptual issues under discussion, is his identification of a farce by Feydau to which Poincare referred quite frivolously. By contrast, Howard's emphasis (e.g., in "Newtonian Space-Time" and elsewhere) upon Newton's sustained critique of the theories of space and motion of Descartes -- whom he does not mention by name -- is conceptually very important, throwing great light on passages in the Scholium at the beginning of Bk. I of the *Principia*, which are puzzling if they are read without attention to historical context. (Incidentally, Howard is a strong critic of Descartes's natural philosophy. He somewhere cites Harvey's famous remark that Francis Bacon writes philosophy like a Lord Chancellor, commenting that Bacon at least had the excuse that he *was* a Lord Chancellor, whereas Descartes had no such excuse!)

(3) Howard is extraordinarily attentive to language. When the classical texts are in English he habitually consulted the Oxford English Dictionary in search of meanings which are now obsolete but may have been intended in the seventeenth century. When English or German or French translations are available for Latin texts, he used them warily, always alert that a puzzling phrase is the result of mistranslation, which he then

investigated with the aid of lexicons and grammar books, in spite of never having been instructed in Latin. A splendid example is his thoroughly persuasive recovery of Newton's ontological conception of space, by correcting (in "On Metaphysics and Method in Newton") the translation by the Halls of a passage in "De Gravitatione et Equipondio Fluidorum." I sometimes was enlisted as an assistant in these philological exercises, because of my course of high school Latin. Typically, the decipherment of a difficult sentence would proceed in the following way: as I tried laboriously to parse a Latin passage, Howard would study it and then offer the conjecture, "Couldn't it mean ....?". His suggestion was always based on the thrust of the argumentation -- what Newton, or Leibniz, or whoever, would have needed to say, in the light of ideas previously expressed. And almost invariably Howard's suggestion was not only compatible with the rules of Latin grammar, but also more natural than other grammatically possible readings. Incidentally, he performed a similar feat of translation of a passage of Parmenides, without instruction in Greek. As philological *tours de force* these feats were awe inspiring. But these dazzling translations are secondary compared to another aspect of Howard's attention to language: his refusal to let antecedent biases obscure the intention of an author. The paper "On Metaphysics and Method in Newton" examines Newton's statement "I never intended to show wherein consists the nature and difference of colours, but onely to show that *de facto* they are originall and immutable quallities of the rays which exhibit them,. & to leave it to others to explicate by Mechanical Hypotheses the nature & difference of those qualities." Howard makes a strong case that Hooke and Huygens, and incidentally some modern historians of optics, failed for doctrinal reasons to appreciate Newton's compact but clear discriminations.

There is an obverse side to Howard's attention to distinctions of a careful writer: namely, his attention to unclarities in an insufficiently careful writer. For example, he makes the apparently novel observation (in "Some Philosophical Prehistory of General Relativity") that Mach's critique of Newton's inference of absolute acceleration from the water bucket experiment actually contains three different arguments-- which Mach does not explicitly discriminate -- with different premisses and different implications. Since Mach is generally considered to have raised the level of critical thinking on the foundations of physics, and to some extent deserves this reputation, the ambiguities in a central portion of Mach's work seem to me a symptom of pervasive carelessness in the professions of history and philosophy of physics, which can be remedied only by Howard's kind of careful analysis and passion to understand.

(4) Howard is a careful student of the works of the great philosophers and applies his knowledge to physical texts and interpretations of physics. Obvious difficulties attend such applications -- there have been radical changes of world view since the Greek philosophers and even since those of the seventeenth and eighteenth centuries; there are radical differences in the textures of analysis and exposition in classical philosophy and in later physics; and there is an admixture of largely discredited physical speculation in the metaphysics and epistemology of early philosophers like Plato and Aristotle that is disconcerting when one tries to extract whatever is perennially valuable in their writings. It takes strong critical judgment, combined with sympathy and imagination, to make good use of classical philosophy when reading post-Renaissance physics. Howard has these qualities and uses them to achieve a remarkable perspective. For example, to me it was surprising and illuminating, and yet after it was said quite obvious, to read his comment

on the fate of Aristotle's causes in the light of Newtonian and post-Newtonian physics (in "How does physics bear upon metaphysics, and why did Plato hold that philosophy cannot be written down?"). Prevailing philosophical opinion since Hume has made the efficient cause the most respectable intellectually of the four causes. But when one considers that for Newton impressed forces do not precede changes of motion but are simultaneous with them, and that in both Newtonian and relativistic physics explanations are fundamentally applications of *laws* of interaction, the efficient cause dwindles to a characterization of certain types of initial conditions. Hence, "the Newtonian forces of nature -- *and* their successors -- are in effect most analogous to Aristotelian *formal* causes".

In the last few decades, with the almost total eclipse of logical positivism and the partial eclipse of other varieties of analytic philosophy, there has emerged a widespread advocacy of the traditional, but somehow suppressed, idea that discoveries of the natural sciences throw light upon fundamental philosophical problems. Howard was an independent pioneer of this renaissance, beginning with his doctoral dissertation in 1958 for the Philosophy Department of the University of Chicago, "An Examination of Some Aspects of Natural Science." More important than pioneering, however, is the solidity, judiciousness, and subtlety of his applications of scientific discoveries to problems that are conventionally classified as philosophical. A few quotations will support this claim.

"On the Notion of Field in Newton, Maxwell, and Beyond" has a discussion of Carnap's distinction between "internal" and "external" questions (which he specializes to questions of existence, but Howard treats more generally). Internal questions are posed relative to a linguistic framework, whereas external questions are posed with the intention

of transcending reference to this or that framework-- and Carnap condemns them as ill-posed and vague precisely because of this intention. HERE Howard grants that often precision is achieved by posing a philosophical question as an internal question and illustrates this assertion by considering the question of the empirical content of a theory, treated "internally" by Newton concerning notions of space and time and by Maxwell and Hertz concerning the concepts of electromagnetism. But he qualifies his approbation by saying

"Where Carnap's notions ... seem to me deficient, is in the treatment of the large-scale evolution of theories. ... If ... it is agreed that the program for a definitive 'language of science has at least *not yet* achieved its aim, and that new theories may require new frameworks, then there is a danger that the internal/external distinction may lead to the neglect of important large questions that span the development of theories -- on the grounds that these are questions external to the frameworks, and that only within a framework are clear criteria of meaning and truth available.... The general (although unsystematic) point of view that I would urge as the correct one here I have already tried to suggest -- in distinguishing philosophically specious positivist criticism from analyses of constructive value like those of Newton and Hertz. No attempt to delimit, systematically and globally, the procedures and notions that are empirically legitimate

-- from 'Hypotheses are not to be regarded in experimental Philosophy' [n.b., a criticism of Howard's hero Newton] to the verifiability theory of meaning and beyond -- has really succeeded. To say this is not to depreciate the efforts ...which have contributed much of value though short of success; but it is to deprecate the

appeal to programmatic notions as if the program had been realized: this leads to specious criticism. On the other hand, *'hypotheses non fingo'* and the verifiability theory meaning both had a valid core; this I earnestly hope we do not forget. It has been possible for scientists, in creating, criticizing, modifying, and revolutionizing their theories, to apply what is valid in these principles, despite the lack of an adequate precise general formulation. There is no obvious reason why philosophers of science cannot do the same."

Two problems that are much debated in contemporary philosophy of science -- the ontological commitments of scientific theories and the possibility that historically successive theories are "incommensurable" -- are treated tacitly throughout Howard's paper "After the Baltimore Lectures: some Philosophical Reflections on the Subsequent Development of Physics," with explicit judgments expressed at its conclusion. HERE1

"In this transformation of the ether problem, the presuppositions of Kelvin have undeniably been left behind: it would be absurd to raise the question of whether the ether or anything like an elastic medium 'really exists.' But it is equally true, although often ignored, that the old notion of 'space', that empty and quiescent container within which bodies exist and forces are propagated, has also been left behind. First, with special relativity, we were led to space-time as the frame whose structure constrained the form of all interactions; then, with general relativity, we were led to the view that space-time is not a quiescent container but is itself interactive; finally, with quantum electrodynamics, we have been led to the view that even 'empty' regions of space-time are seething with -- I almost said 'physical activity', but I suppose it would be more correct to say physical possibilities ...

> As to the other pole of Kelvin's pole, the atoms or molecules ... some of what had seemed their most fundamental properties have fallen away, but their recognizable conceptual descendants have continued to play a role in our theories.

> And finally, a word as to the character of this 'recognizable conceptual descent': What is in fact 'recognizable' is a distinct relationship, from older to newer theory, of *mathematical forms* -- not a resemblance of 'entities.' I do not suggest a philosophical 'explanation' of this fact; I cite it, as merely historical evidence, just as a fact. But I think that, in its turn, this fact helps to 'explain' why an investigator like Lorentz, who was willing to borrow the mathematical structures suggested by older theories and to explore their application in contexts where the presumed 'substrates' of those structures were lacking -- (should one call this 'realism,' or should one call it a purely 'instrumentalist' use of theory?) -- was able so greatly to advance our understanding of the world." [See also Howard's "On Locke, 'the Great Huygenius, and the Incomparable Mr. Newton'", pp. 57-58.]

The hint in this passage that 'realism' or 'instrumentalism' are equally good characterizations is made explicit in "Yes, but... -- Some Skeptical Remarks on Realism and anti-Realism," where he says

> "what I really believe is that between a cogent and enlightened 'realism' and a sophisticated 'instrumentalism' there is no significant difference -- no difference that makes a difference."

One should recall at this point the remark in a previous quotation about the valid core of the verifiability theory of meaning.

Howard Stein's world view is one (of a rather large family) that regards successful natural sciences as revealing approximately the real structure of the world, recognizes the role of common sense in the initiation of scientific investigation, and acknowledges the great discrepancies between common sense and current scientific theory. HERE1 It is a philosophical problem of considerable importance for such a world view to account scientifically for the obduracy of common sense (despite partial educability). Towards the end of "On Relativity Theory and Openness of the Future" Howard offers a convincing solution to one aspect of this problem -- why the concept of a "present" throughout all space is so "intuitive." He explains as follows, meaning by the 'contemporaneity' of an event e and a set of events S that mutual signals or influences can occur between them:

> "the set of events contemporaneous with a specious present will always be a spatially extended one. And it is, I think, of very great relevance to the misconception I am trying to dispel, that this spatial extent -- although finite -- is in fact *and in principle, as a matter of physics*, always, in a certain sense immensely large..... The Minkowski metric can be taken to assign a ratio of lengths not only to a pair of space-like intervals or a pair of time-like intervals, but also to a space-like and a time-like one. The ratio, obtained in this way, of the spatial extent of our bodies to the temporal length of a specious present is exceedingly small: we are temporally long and spatially thin. And the same is true of all the ordinary objects with which we deal -- including the earth. Why should this be so?
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> The question ... has a simple answer..... For although we know little about the physiological conditions required for consciousness to occur, one thing is pretty certain: these conditions involve the coordinated functioning of some part of the

central nervous system. And it is clearer still, so far as perceptions of our surroundings are concerned, that the things we perceive must possess a degree of stability (and must interact with us in stable patterns) ... But according to relativity theory, interactions are not instantaneous: they are propagated with a time delay -- with a speed at most equal to that of light. Now, for stable configurations of particles to be established, and for processes with stable patterns to occur ....it will in general be necessary for very many interactions back and forth to take place throughout the system in question... . And from this it immediately follows that the 'graining' of time with respect to which a percipient organism can experience conscious interaction with its environment must be such that the 'moments' of time (the specious presents) are long enough to allow such signals ... to travel very many times the maximum spatial dimensions of the organism *together* with its (relevant) environment....

But then it is entirely clear why we should have developed 'intuitions' of something like 'cosmic simultaneity', or a 'cosmic present': in all our ordinary experience, the time that we experience as a 'moment', a specious present -- is in the exact sense already explained contemporaneous with events as far distant, spatially, as we ever normally have to do with at all."... But these intuitions are quite .. illusory"

I consider this analysis to be a gem of naturalistic epistemology. More of Howard's gems could be exhibited, but they would be appreciated better in their settings.

I wish now to say something about my relation to Howard. We were classmates during my brief stay at the University of Chicago in 1948-9, where we were both admiring members of Carnap's circle, though by no means disciples. Our friendship ripened further during the years 1961-1967, when both of us were in the Boston area. We played

enthusiastic bad tennis together, studied quantum mechanics together, collaborated on a paper concerning the quantum mechanical measurement problem, discussed his work on Newton during the year of his NSF Fellowship and my work on inductive logic. He was the godfather of my sons, who were born during that period. When he left the Boston area for Case Western Reserve, then Columbia University, then the University of Chicago, we stayed in contact by calls, letters and visits. He read almost all of my papers and gave wonderfully incisive and constructive criticism, to the extent that I have come to regard him as a second intellectual conscience. We shared literary and musical tastes, and I relied upon his immense collection of recordings and fine judgment for recommendations of performances. We shared political anxieties. In sum, he was as nearly a brother as I have ever had. Having said all this -- with gratitude -- I must add that my high assessment of Howard's contributions to the philosophy and history of science, expressed in the body of this essay, is objective and independent of my strong personal affection for him.